Factory

MANAGEMENT *and* MAINTENANCE

February
1934

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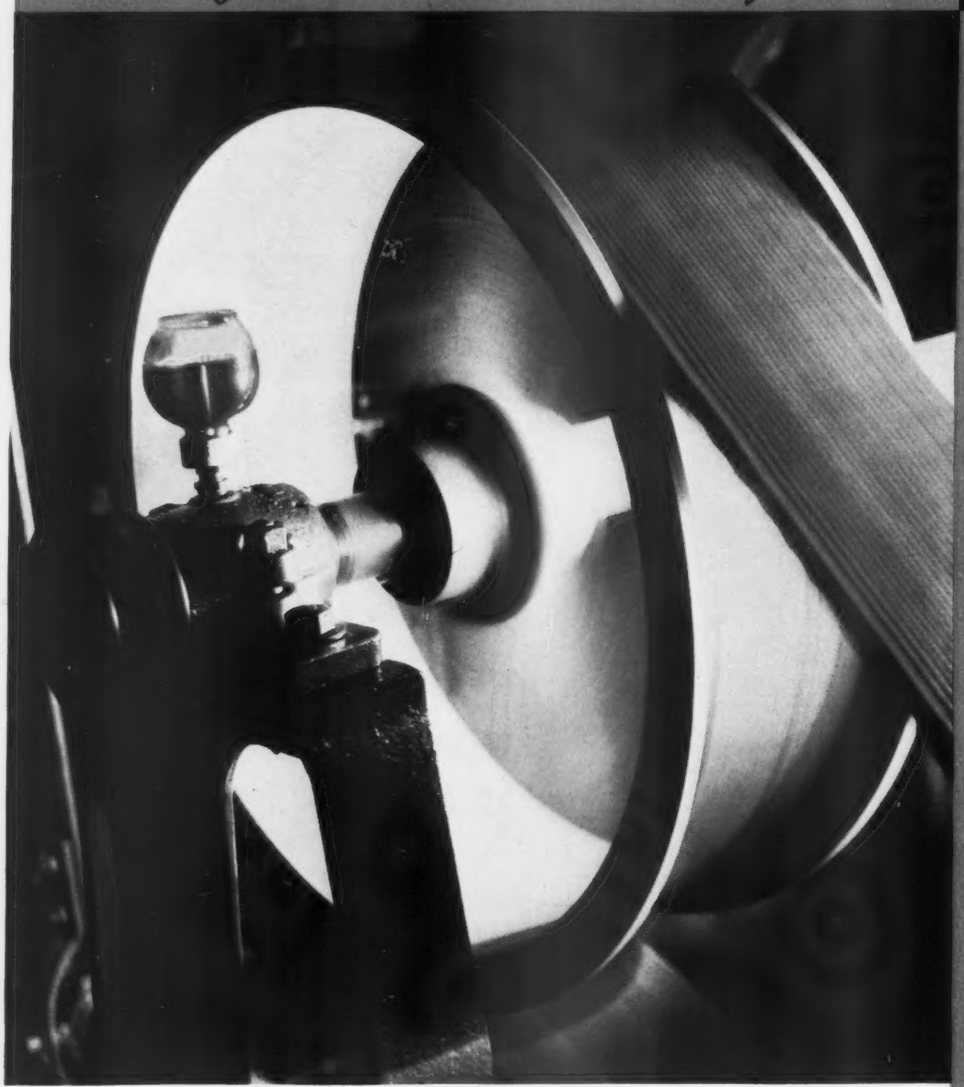

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In the same issue, the application of the variable budget to the control of manufacturing expense . . . more about mechanical power drives . . . how plant layout gets a slice of the motion study melon . . . how one plant laid out its electrical distribution system . . . what a credit union is all about . . . how to rewind d.c. armatures . . . progress in plastics . . . a routine of factory and shop orders, in data sheet form . . . one company's successful plan of getting maintenance costs and actually controlling them . . . and a discussion of the types of inclosures used to protect motors.

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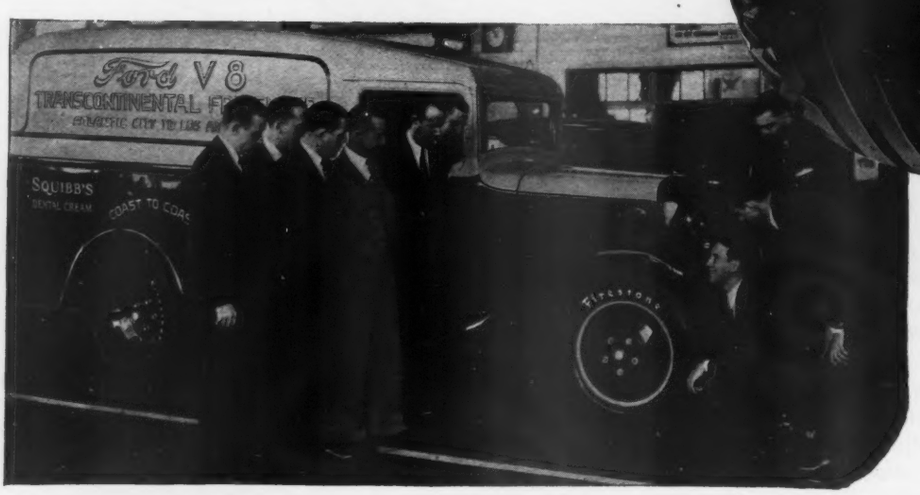

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FACTORY MANAGEMENT and MAINTENANCE

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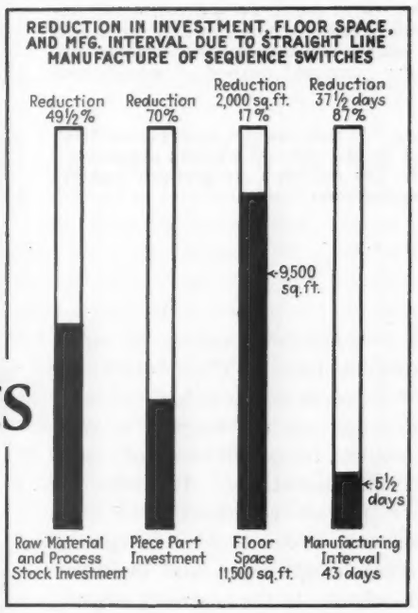
Latest in Layout Did This to Costs


REDUCTION IN INVESTMENT, FLOOR SPACE, AND MFG. INTERVAL DUE TO STRAIGHT LINE MANUFACTURE OF SEQUENCE SWITCHES
Reduction 49½%
Reduction 70%
Reduction 2,000 sq.ft. 17%
Reduction 37½ days 87%
9,500 sq.ft.
5½ days
Raw Material and Process Stock Investment
Piece Part Investment
Floor Space 11,500 sq.ft.
Manufacturing Interval 43 days

Raw-material and process-stock investment cut in half; piece-part investment reduced 70 per cent; floor space, 17 per cent; manufacturing interval, 87 per cent

R. H. Patchen

Manufacturing Development Branch
Western Electric Company, Hawthorne Works, Chicago

This article describes a new development in factory layout. A continuously moving conveyor with double-decked spurs delivers the parts in boxes, selectively keyed so that they will enter any chosen spur. An amazing flexibility is secured by this equipment and its arrangement. Important economies in clerical control and operating cost, investment in stock and equipment, and floor space have been effected.—The Editors

IN THE manufacture of some 100,000 different parts entering into telephone apparatus and equipment in quantities ranging from small to very large, the Western Electric Company has had to deal with a considerable variety of layout problems. It is the purpose of this article to deal briefly with a few of the principles which aid in choosing the layout best suited to a given case, and to describe a particular plan of layout, developed by the company's engineers, which has effected a number of economies for the company.

The various shops contain approximately 3,000,000 sq.ft. of manufacturing floor space. Some of them are set up on a functional basis and some on a straight-line basis, depending upon which is the more economical method of manufacture for the particular item. Those items which are new in design, or in a state of flux or change, or for which the annual requirements are small, are made more economically in functional manufacturing departments.

In functional manufacture the departments are set up to perform specific functions in the process of fabricating and converting raw material into finished parts. With this arrangement machines are segregated into departments by types; for example, punch presses in one department, screw machines in another. In straight-line manufacture the departments are set up to be responsible for the complete manufacture of a particular unit of the apparatus rather than for a particular type of operation.

In functional manufacture the component parts of each unit of apparatus are routed from department to department where the operations are performed in proper sequence. After the parts are finished they are delivered to specialized assembly departments where the apparatus is assembled, adjusted, and inspected by progressive methods.

It is evident that each unit of apparatus will consist

Presented originally before the Chicago Chapter of the Society of Industrial Engineers; revised for publication.

Figure 1. An assembly department typical of the functional arrangement

Figure 2. Another functional set-up—the medium-sized punch press department. Automatic screw machines, milling machines, and other kinds are similarly arranged under the functional method of manufacture

Figure 3. Still another example of functional set-up—the coil winding department, where like machines are grouped together in regular rows

of a considerable number of small component parts. These parts require different numbers and types of operations, and the lengths of time to complete them will obviously vary with the operations. In order to insure proper coordination of the movements of the work through the different departments, and to insure their delivery to the assembly departments when required, it is necessary to have a production organization whose function it is to schedule the work and to follow the parts through to completion.

Functional type of manufacture has many advantages such as the specialization of personnel on definite types of operations, the concentration of single types of equipment within departments, and the flexibility which is obtained through the ability to utilize machine time for various operations on different parts and on many types of apparatus. Despite the amount of handling, accounting, production, and clerical work required for functional manufacture, it is the most economical for those items which are subject to change in design or have small production requirements.

Figure 1 shows one of the assembling departments and is typical of the set-up in punch press, screw machine, and other departments under functional arrangement. In this spring assembly, each girl assembled a pile-up complete and placed it in a paper box for delivery to subsequent operations. Notice the quantity of work stored ahead of the operators.

A view of a department containing medium-sized punch presses is shown by Figure 2. Here you will note that many punch presses of a like class are grouped together, spaced sufficiently far apart to insure easy handling of raw material and parts. Automatic screw machines, milling machines, and others are similarly arranged under the functional method of manufacture.

Again, in the coil-winding department, Figure 3, like machines are grouped together in regular rows.

Raw material is delivered to these departments, and the partially finished parts are shipped to other departments for further fabrication until they are completed.

It can be readily seen that in functional manufacture there will, of necessity, be a large amount of interdepartmental trucking. Even the departmental trucking is a considerable item. In addition, storage space must be provided in each of the departments for incoming

and outgoing work, and work which is awaiting an operation.

The foregoing illustrations and description of manufacture under the functional set-up have been given in order to make more apparent the contrast between that method and the straight-line method that will now be described.

Those items which have become established or settled in their design, or for which there is a large steady annual production requirement, are made in straight-line departments. For many years some of our products, such as lead-covered cable, have been made in straight-line or unit-manufacturing departments. In these departments the raw material goes through all manufacturing operations, and the finished product is completed.

As the design of the apparatus becomes established and the requirements increase after the use becomes more general, it becomes more economical to manufacture the apparatus on a straight-line basis. One unit of equipment which was recently transferred from the functional to the straight-line basis is known as the sequence switch, a piece of apparatus used in machine-switching telephone exchanges.

In making the change, the manufacture of this unit was analyzed part by part and operation by operation, and the types and amount of equipment required for its complete manufacture were determined. The required equipment was then collected and concentrated in one department, together with the final assembly and testing, under the supervision of one foreman.

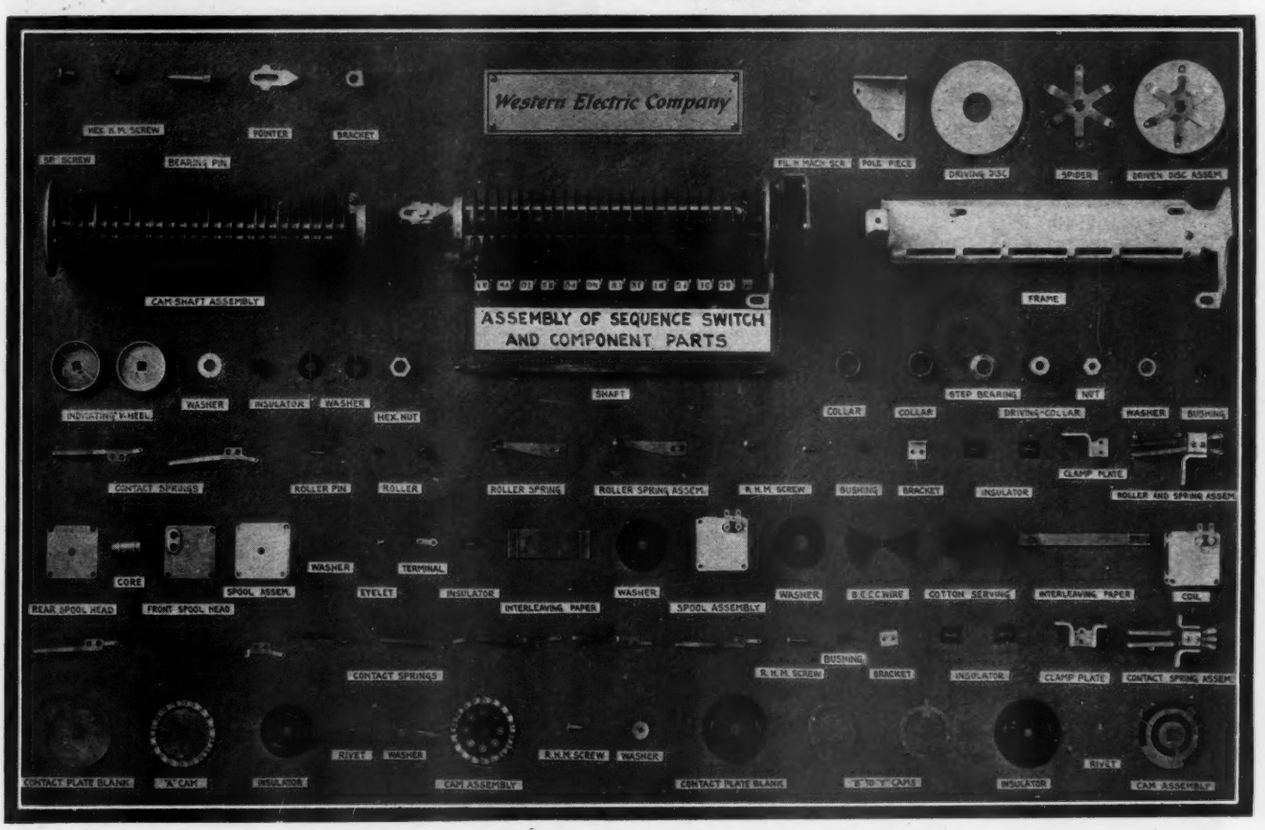
Orders are placed on the department for completed units as required. The personnel of the department analyzes each order for completed apparatus, breaks it down into component parts, requisitions the necessary raw material, fabricates and completes the parts, and makes the final assembly.

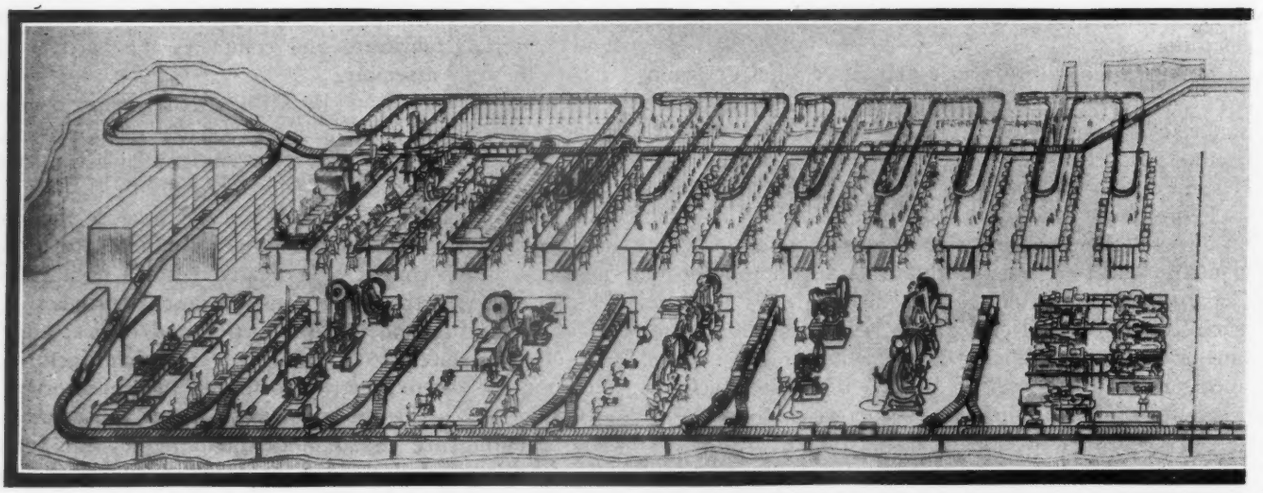
This newly established department has been in operation a sufficient length of time to make possible some fairly definite conclusions concerning the advantages and limitations of straight-line organization. Those conclusions will be of especial interest because the use of straight-line manufacture is largely limited to those products which consist of a relatively small number of parts for which there is a constant large demand.

It has been found that production and clerical effort has been reduced to a minimum; the manufacturing interval has been greatly shortened; the inventory of work in process has been reduced; inspection, counting and handling are less than that required by the functional method; and manufacturing difficulties have very largely disappeared. These things have been accomplished in a large measure because of the centralization of responsibility which is obtained by the set-up. The management of the department is in the hands of men who are close to, and familiar with, the details of its operation, and the organization is small enough that control can be exercised without any considerable reference to records.

Shown in Figure 4 is the sequence switch manufactured in the newly created straight-line department, together with the parts and sub-assemblies of which it is composed. This switch is part of a telephone exchange, or "Central," for use with automatic, or dial, telephones. By referring to the peculiar-shaped notching of the

Figure 4. The sequence switch, manufactured in the newly created straight-line department, together with its parts and sub-assemblies





cams in the lower portion of the photograph it will be seen that there can be a great diversity in the type of cams. Because of this the apparatus is built entirely on a customer-order basis, since each cam must be designed and built to perform a particular function dependent upon the circuit requirements of the exchange into which it is to be installed.

A perspective drawing of the straight-line installation is shown in Figure 5. Encircling the entire department is a continuously moving live-roll conveyor. Spurs branch out from the main loop between rows of machines and onto assembly benches. This conveyor is used to carry pans of the piece parts from machine to machine during their fabrication and finishing, and after completion to their respective assembly benches. Work can be put on at any spur and keyed so as to be deflected automatically at the spur adjacent to which the next operation will be performed. The spurs serving the machines are double-decked, the lower deck being for incoming and the upper for outgoing work.

In the lower right corner are located the raw material storage racks. Adjacent to these are two punch presses which make the springs complete, using a perforating, blanking, and forming tool. To the left is located a group of punch presses and drill presses used to form and drill the frame. A spur of the conveyor encircles each of these punch presses. To the left of this group is located a group of automatic and hand screw machines, used to make the spacing collars and similar parts.

Further to the left are placed the blanking and forming punch presses, used to make the bracket and similar formed parts. In the left section are located several miscellaneous machines which mill, drill, tap, rivet, polish, and grind various piece parts. In the upper left quarter of the layout are located the assembly, adjusting, tensioning, and inspection groups, each served by an individual overhead conveyor. In addition, each of the assembly benches is served by an incoming spur from the main conveyor. In the upper right quarter is located the heat-treating and metal-finishing group of equipment. This equipment is also served by a spur from the main live-roll conveyor.

One of the striking points about this floor layout is the flexibility which is made possible by the main conveyor encircling the department with spurs to transport the parts being manufactured. By this means it is possible to obtain all the advantages of having the equipment involved in making a complete part arranged in a group, so that parts can be moved from one machine to another by means of chutes or conveyors. The latter arrangement requires careful planning to obtain the best group arrangement and, at best, requires more equipment because of the impossibility of always balancing the operating time of all machines, in many cases resulting in a low average machine activity. It has the additional disadvantage of the possibility of such fixed group being disrupted because of changes in design. The loop conveyor makes possible the grouping of machines by class or type; in effect, it has all the advantages of grouping by operation with none of the disadvantages,

Figure 6. One of the double-decked spurs located between two rows of machines. The work from the main loop comes in on the lower level; the upper level is used to carry work back from the spur to the main loop

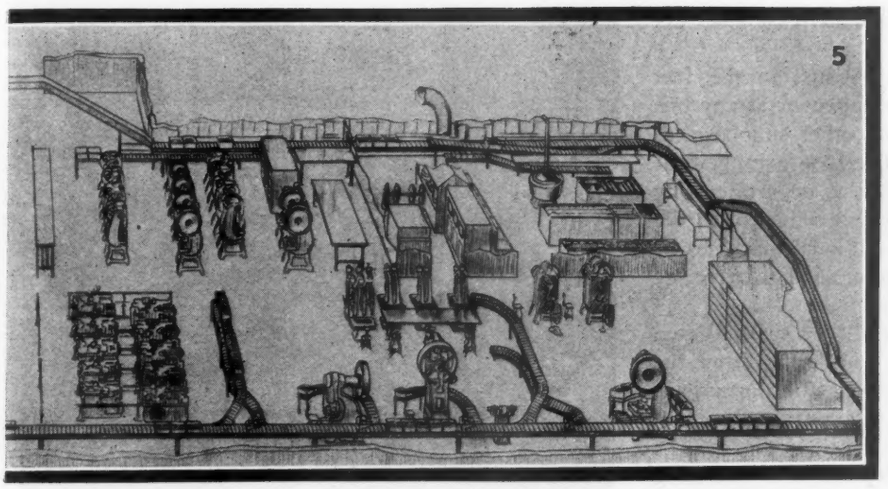


Figure 5. Straight-line installation now being used. Encircling the entire department is a continuously moving live-roll conveyor. Spurs serve machines and benches. Work pans are keyed for automatic delivery to working points

Figure 7. A close view of the switch mechanism for deflecting the pans

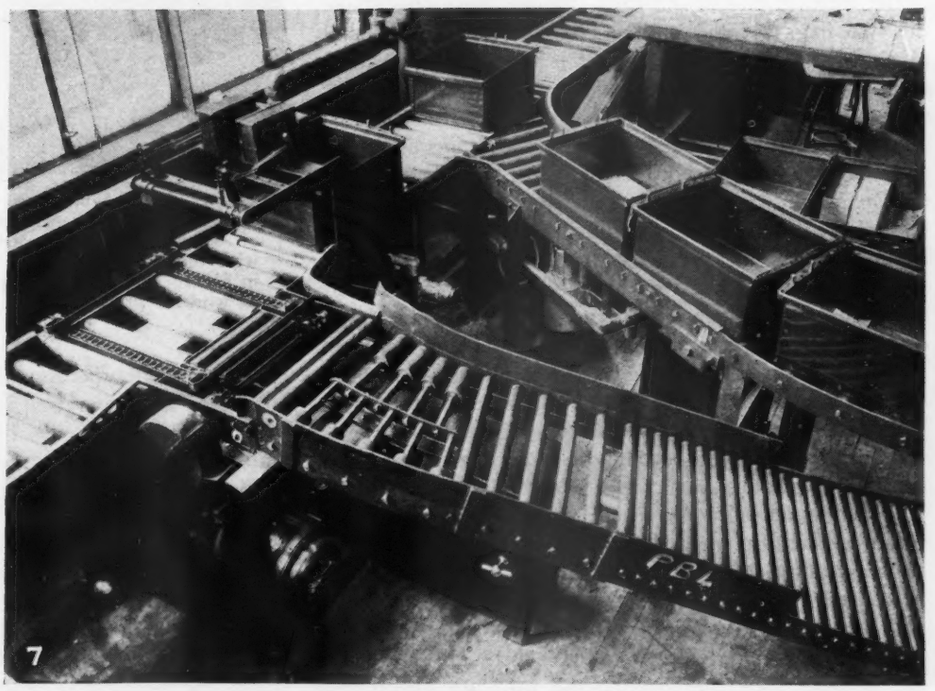
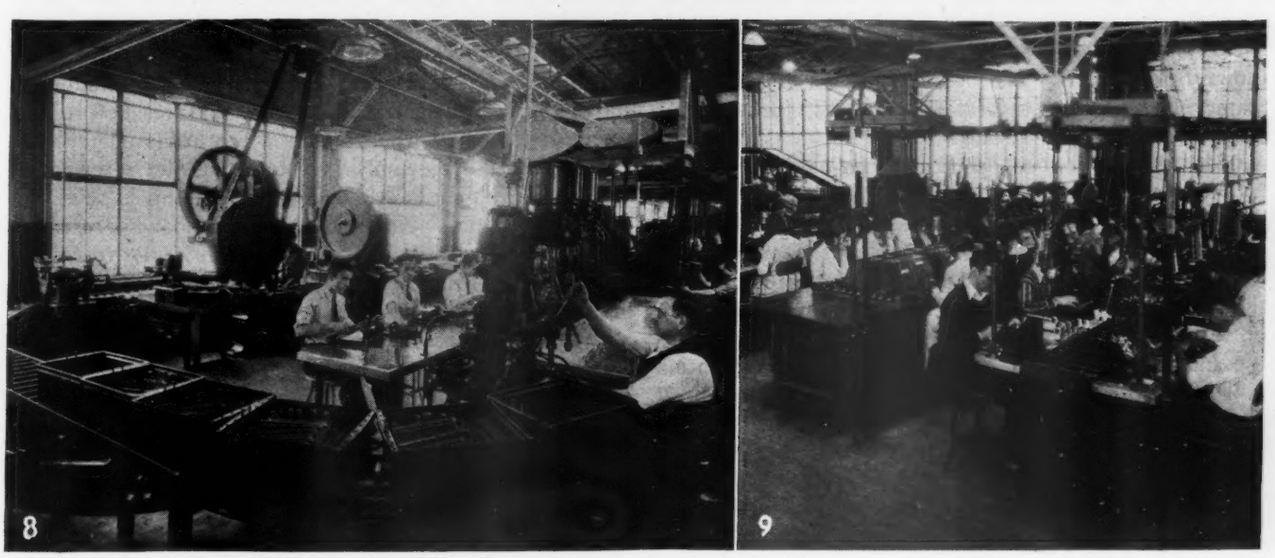


Figure 8. How the conveyor spurs serve the group of machines used to manufacture the frame

Figure 9. A group of assembly benches. The spur for incoming parts is at the center of the bench. Assembled parts are hung on the overhead conveyor for delivery to the adjusting operation



thereby resulting in higher machine activity and less plant investment.

This feature of flexibility is attributed to the fact that the work can be placed on the conveyor at any one of the spurs and be deflected at any other spur regardless of its position on the loop. The loop arrangement also makes it possible to expand the department by merely moving the end portion of the conveyor to the right, and adding spurs for such additional machines or equipment as may be required to accommodate a change in design or an increase in output.

Figure 6 shows one of the double-decked spurs located between two rows of machines. The work from the main loop comes in on the lower level; the upper level is used to carry work back from the spur to the main loop.

A close-up of the switch mechanism for deflecting the pans is shown in Figure 7. Two pins are located in the forward end of the pans. When these pins strike the two flags pivoted on the crossbar at the left-hand side of the photograph a circuit is closed which causes a pusher bar to push the pan from the main conveyor onto the lower level of the spur. The switch is actuated only when both flags are operated simultaneously.

These flags are spaced differently for each spur; hence only pans with pins set to correspond to the flags will be deflected, and all others will pass on through. This lower-level spur is protected from being jammed with pans by means of a safety roller which is depressed by the weight of the pans when the spur is full, opening a circuit and preventing other pans from being deflected from the main conveyor onto the spur and so causing a jam. Pans thus refused simply continue on around the loop, circulating until they can be accepted.

Thus the conveyor becomes in a real sense a traveling storage of parts, always ready for immediate delivery whenever required. As space is vacated by pans being removed from the spur, the safety roll returns to normal, allowing additional pans to enter. A jam which might be caused by a pan leaving the upper spur and attempting to enter the main conveyor while another pan is passing the opening, is prevented by throwing up a brake which holds back the pans on the spur until such time as sufficient space is cleared on the main conveyor to allow the pan to enter. This action is entirely automatic.

A group of machines used to manufacture the frame is shown by Figure 8. The operations for converting the frame blank into a perforated, embossed, formed, and stamped frame are performed on punch presses along the outside wall. Between operations the pans are stored by being circulated on the main loop of conveyor until the spurs which serve the presses are able to hold additional pans. This arrangement makes it possible to take work from a pan on the incoming spur, perform the operation on the press, and place the work in a pan on the outgoing spur, re-keying the pan for deflection to the spur adjacent to the press where the next operation will be performed or to the drill press spur shown at the bottom of the illustration.

The incoming pans on the lower deck of the conveyor are received for the drill presses and the frames are removed, straightened, and passed along to the right to the drill press operators. After being drilled they are returned to the operator at the extreme right, who performs the final operation in this series, places the frames in a pan and dispatches them to the main conveyor for transport to the plating section.

Figure 10. The belt conveyor used for the assembly of spring pile-up carries fixtures before the operators, each of whom adds to the assembly. Compare this set-up with the functional set-up of the same operation shown in Figure 1, and note saving in space, also reduced amount of work in process

Figure 9 shows a group of assembly benches. Pans of parts come in on the spur which is located in the center of the workbench. After assembling the parts to the switch they are hung on the overhead conveyor for delivery to the adjusting operation. The speed of this conveyor serves to set the pace of the work. It is interesting to note the small quantity of work on and about the benches as compared with that shown on the photographs (Figures 1, 2, and 3) of the functional method of assembling.

The belt conveyor which is used for the assembly of the spring pile-up, Figure 10, consists of a continuously moving belt conveyor which carries fixtures before the operators, each of whom places a few parts on the fixtures until the assembly is completed, the screws are tightened, and the assembled spring pile-up is removed from the fixture. Notice the reduced floor space occupied and the reduced quantity of work in process as compared with the method of assembly previously shown in the functional department.

Some of the results accomplished by the change, such as the reduction in investment, floor space, and manufacturing interval due to the introduction of straight-line manufacture, are shown in the headpiece, page 47. The raw-material and process-stock investment was more than cut in half, and the piece-part investment was reduced about 70 per cent. Floor space was reduced 17, and manufacturing interval about 87 per cent.

An Experience in Employee Representation

Ten Years With a Works Council

Last month, why and how the works council was set up. This month, how it helped establish fair rates, handled privilege seekers, ironed out dissatisfactions, changed so-called radicals into good plant citizens, uncovered supervisory material—your questions answered, your doubts diminished

C. J. Stuart
Industrial Engineer, New Haven, Conn.

ONE OF the early things put before the council by the management was the need for placing more jobs on piecework and developing a more satisfactory method of setting rates. In the past, rates had been pretty much determined by the foremen, and a check of the earnings throughout the plant showed some groups with very high earnings compared with others whose earnings were low.

We explained to the council that our wage policy would be to pay an average worker as much as or more than the average wage in the community for similar work, and that we would pay by piecework rates determined by time-studying several individuals on each job.

All major jobs in the factory had been surveyed and basic 48-hour weekly wage rates set which average workers should be able to earn. These basic wages were determined by the skill required, the heaviness or the unpleasantness of the job, and by the labor required —male or female.

Employee representatives were asked to aid the foremen and time-study men in seeing that their groups understood the matter and cooperated by giving a fair speed of work during time studies, so that rates could be equitably set.

A time-study man then explained to the council how he took time studies and how rates were determined. He also explained that his job was not completed until average earnings came up to basic weekly wages.

Shortly after this council meeting, the management decided to increase wages an average of 10 per cent on account of the increasing cost of living. This seemed a good time to start bringing the wages of various groups into line with each other, so we decided not to give an even 10 per cent increase to everybody, but to give a minimum increase of 5 per cent and grade up according to our list of basic wages, making the total increase 10 per cent of the total payroll. The council agreed that it seemed the fair thing to do.

There was one small group of men, numbering about 25, who worked at preparing a certain part for the assembling department. This was all hand work and required considerable skill. Wages were high, compared with the basic wage set up for this type of work, because in the past, and especially during the war period, this group had received larger increases than other groups by threatening to walk out, and also because the men had fooled the foreman into setting rates too high on new work.

As soon as their council representative told them that wages were to be increased, but that they would probably get the minimum raise of 5 per cent, they demanded, through their foreman, that they receive a 25 per cent increase or they would walk out.

This was an ideal case to put before the council, so its members were shown the weekly earnings of this group over a period of time, and told that if the company had tried to pay all employees in the same proportion it would have been forced out of business and they would have been out of jobs.

The management represented that its stand on evening up wages was the fair thing for all employees. The next day the chairman of the council reported that the representatives and most of the other employees believed that the management was fair and that the group which was looking for special privilege should not get it.

This decision was given to the dissenting group by their representative and the group decided to stay away from work the next day. A few of the men, including their council representative, showed up and with volunteer workers from other groups the work went on, although ragged in spots.

After cooling their heels for a few days, and finding that the bulk of the employee opinion was against them,

the men sent a committee to see the management about returning to work. We decided that the proper place to handle their case was before the council. The latter recommended that the men be allowed to return to their jobs, except two who had been known as trouble-makers and had instigated this walkout.

It is of interest to note that sometime after this walkout a foreman in another department worked out a machine on which, in time, all of the work of this group was done. This was the last walkout of employees seeking special privilege.

Subsequently there were walkouts of two small groups, but these were caused by unintentional mistakes in judgment on the part of the management, and were quickly cleared up without loss of the employees' standing with the company and with no hard feelings.

Due to the amount of hand work being done, we set up a machine-development department to search the market for machines which could help us, and, where no machines were already on the market, to develop new ones. We also put in conveyor assembling lines and simplified complicated jobs by splitting them into two or more jobs, which increased production speed.

Since the council members knew that each time a move was made along this line less labor was needed, they were naturally disturbed and brought the matter up for discussion. The management promised that no one would be laid off because of a change in methods, although a good many employees might have to be transferred to new jobs to balance production. Within two years the number of employees needed for the same amount of production was reduced from 1,700 to 1,200, but no one was laid off as a result of new methods. Natural labor turnover took care of the decrease.

During this time plenty of cases had been brought before the council. Individuals were upset over being changed to new work. Sometimes a whole group would protest a sweeping change in method. The management tried to make all the changes as easy as possible for the employees involved, and the works council was a great aid in seeing that no injustice was done. Perhaps it was fortunate for the council plan that it was put in during a period of rising wages.

With each increase in wages we followed the plan of correcting high or low wage rates by not giving uniform increases on all rates. Many protests came to the council from groups not getting the same increase as others, but after all the facts in each case had been presented, the council usually agreed that the practice was fair, although in some cases it recommended changes that were accepted by the management.

Before coming into the sharp business depression of 1921, factory costs were well in hand. We were producing goods much improved in quality and at a cost that compared with the lowest in our industry. Employees were working shorter hours, with higher average earnings, and the amount of work on incentive had increased from 60 to 95 per cent of the total payroll.

During the depression a most important problem was what to do with surplus labor. We presented several plans, and the council recommended keeping all employees on the payroll and adjusting hours to suit production.

The management agreed, and the factory was operated from two to five days per week, as orders warranted. This worked out to the advantage of both the company and its employees, because the employees, being informed by their council members, kept up both the quality and the efficiency of their work. When business improved, we had a full force of trained employees.

It was found necessary to reduce wages during this depression, and again we took the opportunity to equalize rates by not making a uniform decrease. The council again helped by keeping employees informed as each move was made.

Several interesting things developed as time went on. The foremen had been afraid that the more radical representatives would try to run the council and create trouble over our plans to reduce costs. It did not turn out that way. The radically inclined were always a small proportion of the total number of representatives, and the management's method of presenting all the known facts in every case convinced them that the company was trying to operate fairly.

Answers to Questions

Can a works council be successful in any industrial plant?

This lies entirely with the management. An employees' council will be a success in any plant if the management, from the manager down through the foremen, really wants to make it a success.

All members of the management must want to give each employee the best deal possible. They must look on the employees as individuals like themselves, who are looking for fair treatment as individuals, good working conditions, and a reasonable income in return for a reasonable amount of work.

A works council can be successful only as a plan whereby employees can bring their cases before a sympathetic management and get a fair deal.

The management must be ready and willing to pay the highest wages that the industry can afford, offer good working conditions and reasonable hours, and employ intelligent, fair supervisors.

What is your opinion of the benefits that employees can get under a works council plan, compared with what a regular trade union offers?

In an industry which has an efficient management, known to be fair to employees, I think that a works council can benefit all employees to a greater extent than can a union whose delegates are also dealing with other managements less efficient and only as fair to employees as they are forced to be.

In a works council the employee representatives are acquainted with the management representatives, and they are all intimately concerned in the questions raised. Employees are kept informed about new plans that may affect them. Problems are brought up and solved while they are small, instead of when they have grown to a point where a strike is impending.

Through the council the employees can get their viewpoint directly to the management, and the management can be entirely frank in return, because all of them are in the employ of the same company.

Employees are not continually bothered by troubles in other plants with which they have no connection, and they have no dues to pay.

On the other hand, employees of a company whose management is hard-boiled in its belief that employees have no rights and should be paid as little as can be gotten away with, and worked long hours under poor conditions, will get greater benefits if they organize in a strong union which can keep the hard-boiled management in line by strong-arm methods. With this

My private opinion is that most employees who are said to be radical get that way because they can find no means to be fairly heard, and I would much rather give them a chance to talk out in council meeting where if they have a real grievance the management can at least try to correct the conditions that are disturbing them.

We found that so-called radicals became very good representatives of their groups of employees. With a fair chance to be heard, they developed into first-class aids to the management in correcting conditions that were bothering the employees.

When the works council was first installed in our factory, other business men in the community predicted that the employees, through the council, would try to run the factory. During ten years of the works council we found this was not so. Employees want the highest wages an industry can pay and operate successfully; they want fair and considerate treatment as individuals; they want good working conditions and not too long hours of work; but they absolutely do not want any of the responsibilities of management. They do, however, want to work for a management that is capable of taking the responsibility for operating the company successfully.

If the management has the confidence of the employees, those employees, through a works council, can be of great help in the smooth operation of an industrial unit.

A works council will turn the spotlight on poor management in any part of the organization. Our council turned up one foreman who was assessing his employees a certain amount each week for his own pocket, and a sub-foreman who was objectionable to the young women in his department.

The council pounded away at poor service and quality of work from other departments until conditions were corrected, and they showed up instances of foremen and inspectors playing favorites in their departments. A great many constructive things were brought out in

(Continued on advertising page 44)

I've Been Asked About Works Councils—

type of management a works council could be only an hypocrisy, installed to salve over a sore situation, and benefiting neither employees nor management.

Will the organization of a works council stop successful organization by an outside union?

The set-up of a works council plan will be successful only if the majority of the employees are confident that, through the works council, they can get greater immediate benefits than through some other form of organization. Employees pay dues to a union and take the chance of being involved in strikes and craft disputes when they feel that that is the only way in which they can get a management to give them a fair deal on wages, hours of work, and working conditions.

It is, of course, a waste of effort to set up a works council if the management officials do it solely because they consider it a lesser evil than having the plant unionized; but, if a management has the confidence of its employees and is honestly concerned with giving them every benefit possible, then I believe that a works council plan will forestall any attempt to unionize the plant.

Does a small plant need a works council plan?

Not if the plant is a small one where the manager can know each employee personally, and can talk with each one, and learn exactly what is bothering him.

How does the National Industrial Recovery Act affect works council plans?

In the past the management of an industrial plant has had the right to determine what form the contact beween employee and management should take.

The NIRA reverses this procedure. Now it is the individual employee who has the right to decide how he will contact with the management.

The employee can decide to deal individually. A group of employees can decide to deal through representatives of their own number. This would be a form of works council. The entire group of employees, or any of them, can join a union and deal with the management through union delegates.

The Act, however, does not give any group of employees the right to force others to follow their method of dealing. It simply affirms the individual right of an employee in his dealings with his employer, and he cannot be legally forced by employer, fellow employees, or an outside labor union to give up this right.

The management may present a works council plan and the labor unions a union plan for mass bargaining, but each employee has the right to select either plan or elect to deal individually with his management. It is all a question of whether or not the majority of the employees have confidence enough in the management to elect employee representatives to sit in a works council with management representatives and work out mutual problems as they arise.

Will a works council be of benefit in a plant where employees and management are apparently already working successfully together?

A works council should be particularly successful in such a plant. It will be surprising to find how many small things lie just beyond the management's attention and can be brought forward only through some regular channel, such as a works council. These small things are the ones which grow, unknown, into the larger problems.

From the management angle the works council is ideal for getting a cross-section of employee opinion on any problem. Company plans can be presented and discussed and modified, if necessary, to get the fullest employee cooperation. That procedure takes the guesswork out of wondering what the employees, as a group, are thinking; and for the employees it takes the guesswork and rumors out of what the company is doing and why it is doing it.

Why have some of the works council plans failed and been dropped?

The success or failure of a works council plan results from the same causes that bring about the success or failure of any other business plant.

Any plan must be carefully worked out with a definite objective in view, and it must be intelligently administered, with the thought always on the objective.

The principal objective of a works council plan is to give all employees the best deal possible. The benefit to the management must be considered as of secondary importance.

I think that a works council failure can be laid to such causes as half-hearted cooperation on the part of the management; the placing of management's benefits ahead of the main objective, which must always be the employees' interests; lack of confidence in the ability of the council to protect employees' interests. This all boils down to the fault of management, which either does not understand the objective of the council, or does not realize that employees have rights a management must uphold.

Cost's Influence in Choosing

When physical limitations and production advantages do not dictate the choice between group and individual drives, selection is commonly based on relative costs, summarized here for different types of plants

IN THE December issue the effect of the type of mechanical power drive upon production was discussed. It was concluded that one or the other type of drive (group or individual) is almost necessary in some applications, principally because of physical limitations, and that in other applications one type or the other shows decided advantages from the standpoint of production. It was pointed out that the effect of delays upon production is not always in proportion to the number of delays, but rather to the kind of delay. The first conclusion was that with the mechanical transmission equipment and motors now available to industry a very large group of applications may be driven about as well in one way as the other.

Even when there are decided differences from the production standpoint between the two methods, relative costs are often considered before making a decision. When one method is as good as another, the choice is commonly based chiefly on cost. Following is a brief summary of the relative total first and annual costs of the two types of drive.

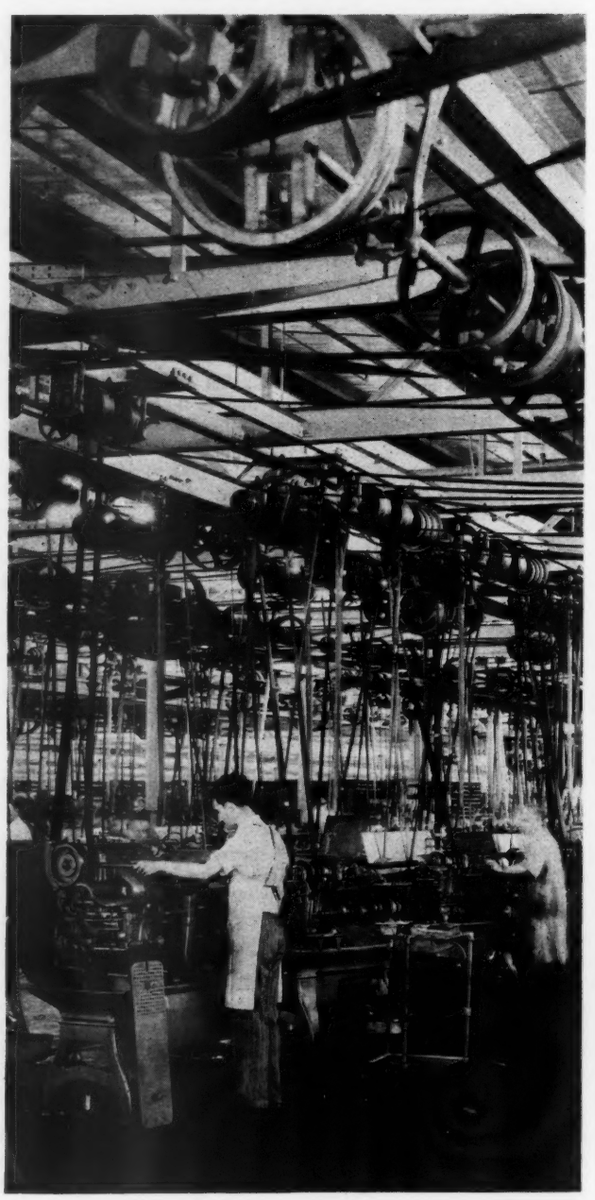
To be of any use as a guide in the analysis of other problems such a comparison must be worked out in considerable detail. Furthermore, it is necessary to divide operating plants into a half-dozen types and consider each type, which would require far more space than is available here.

Such an analysis has been published.* It will suffice to quote here a summary of conclusions from that series of articles. The tabulations in those articles will be helpful in suggesting the items of cost that must be given consideration in any similar comparison made to suit the conditions of a particular installation:

1. In the typical American manufacturing plant, which averages over a ten-year period a little less than single-shift operation at maximum capacity, with a large night shift in the busy season of boom years and short-time operation in the depths of a depression, the first cost of electrical power and mechanical transmission items, including power factor correction equipment, switchboards, distribution cables and ducts, for the individually driven plant is 80 to 95 per cent more than for corresponding group-driven plants.

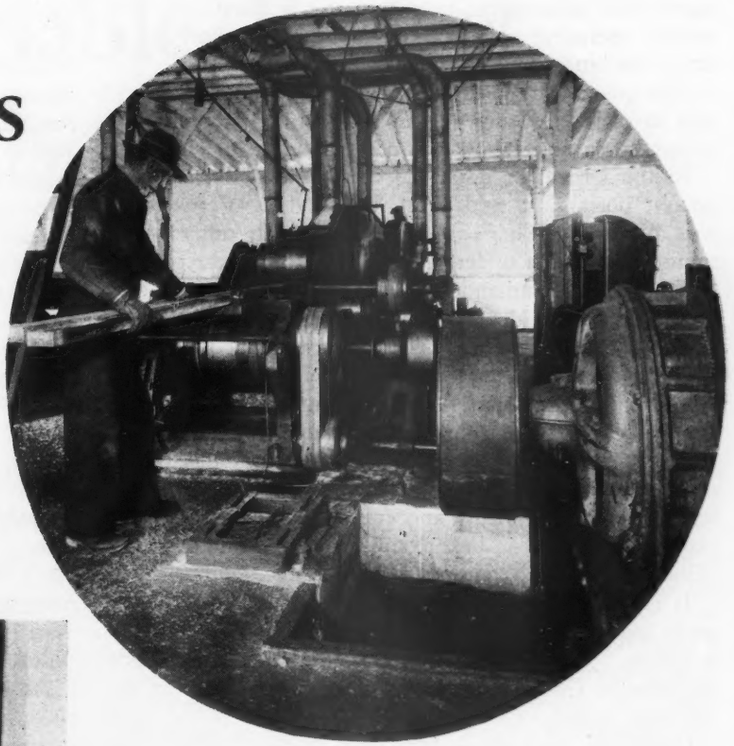
Total annual costs, including fixed charges, for the same equipment are about a third higher for individual than for group drive—a trifle more if the motors average only 1- or 2-hp. rating.

2. For the familiar "feast or famine" industry—the plant in which some departments work day and night



Maintenance Engineering (now *Factory Management and Maintenance*) June, July, August, September and October, 1932, by Robert W. Drake.

Power Drives



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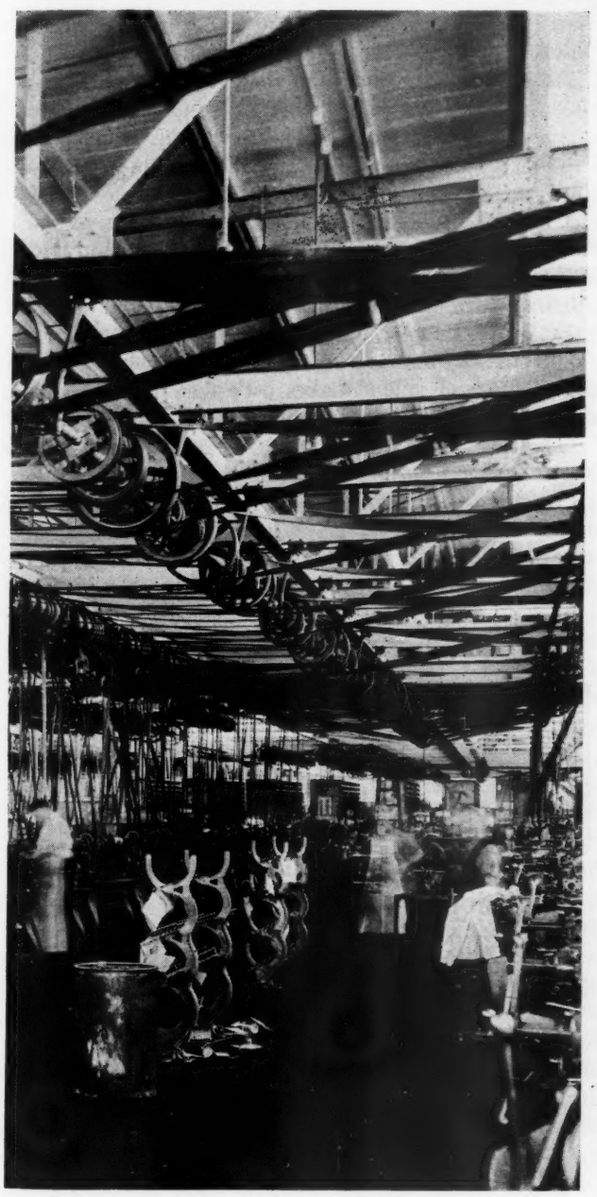

while others have nothing to do, and which shuts down almost entirely in a depression year or in the dull season—the total annual cost will amount to about 50 per cent more for individual drive, and will be somewhat higher, relatively, if the individual motors average only 1 or 2 hp. in size.

The first cost of the whole power layout, including the mechanical power transmission and other items mentioned previously, will be from 2 to 2.2 times as great for individual as for group drive. The lower figure will hold for an industry in which 4- to 10-hp. motors on the average are required on individual drives. The larger figure will apply when the motors are smaller, say, 1 to 2 hp. in size.

3. In a plant that averages two shifts except for single-shift operation in a dull season of three or four months' duration, with three shifts in boom years and one shift in depression years, the total annual costs for individual drive will be 25 per cent greater than for group drive. These costs will be a trifle more relatively if the individual-drive motors average 1- to 2-hp. rating, and a little less if 5 to 10 horsepower.

The initial investment in electrical power and mechanical transmission equipment, including power-factor-correction equipment, switchboards, distribution cables, and all, will be about 80 per cent greater for individual than for group drive. It will be 10 per cent less than that if the motors are 5- to 10-hp. rating, and 10 per cent more if the average size is 1 or 2 hp. Such plants are uncommon.

Assumptions as to performance on which these comparisons are based apply to the best-planned and operated plants of their respective types, not to average plants.

It is evident, therefore, that where no decided production advantage exists it is in the great majority of

cases more economical in the matter of first cost and annual operating expense (including fixed charges) to drive machines in groups.

The question immediately arises as to how to recognize cases where other matters than first cost and maintenance cost make unit drive preferable.

In the December issue the matter of manufacturing delays, portability, and ease of relocation of machines was discussed. There are, of course, many other determining conditions under which one or the other type of drive offers definite and marked advantages.

It should be evident from the discussion in this article and the article in the December issue that a blanket decision cannot be made as to the type of drive for a whole plant, particularly a large plant. A forge shop and a foundry, a woodworking department and an upholstery room, a sheet metal shop and a grinding department cannot be logically lumped together. Each presents its own problems and must be considered separately. Indeed, for best results, many individual machines must have separate consideration.

It is quite commonly found advisable to drive one or more machines individually within the area covered by a group. An example is found in a case where one machine is frequently operated overtime while the remaining machines in the group area are idle. Not infrequently there are several such machines in a room. Occasionally they can be placed in a small group together, but quite as often other considerations, such as materials handling, make this inadvisable.

Frequently group drive proves best, everything considered, in side bays or on balconies, whereas individual drive is definitely preferable in the center spaces, where heavier machines are located or where crane service is needed.

A considerable amount of judgment still is necessary in determining the best drives for the machines of a department. So far as is possible with the data available, a comparative tabulation on a dollars-and-cents basis is very helpful.

Commonly a study would be made for representative machines or representative groups only. Unfortunately, in very few plants is it possible to obtain the data necessary to make such a comparison.

In most industrial plants, the cost of purchasing or generating power and distributing it forms a relatively small portion of the total manufacturing costs. The object of the accounting methods in use is to distribute power and kindred expenses equitably upon various manufacturing costs. Frequently nothing more than an equitable power cost per unit of product is desired. Accounts set up with such objects in view are ill-suited to furnish the detailed costs necessary for a study of the relative operating costs of group and individual drives. In the average plant certain maintenance accounts are notorious "catch alls" into which very diverse items sink from sight.

Nor are matters greatly improved if an involved system of separate accounts is set up. For such occupations as motor inspector, oiler, belt man, maintenance electrician or millwright, experience proves that any demand for a division of time for a single half-day's work between a number of accounts results in inaccurate costs, to say the least. Such a man does not know what the actual division of time was, no one else knows, and he puts down something, generally an even split. By somewhat different methods fairly reliable figures for relative power expense may be obtained, but in only a few industries is it possible to evaluate the cost of delays. In many comparisons heretofore this matter of delays has been entirely neglected. Where an effort is made to include it, the cost will vary widely under difference circumstances in the same department.

In the slack season, or in the depth of a depression, a motor failure may offer a welcome excuse to "send the men home" for a day or two. On a rush shipment, already overdue, a delay may lose a customer. In a plant manufacturing a seasonal product, and two months behind in orders, a delay may well mean loss of the sale of the production lost. In a plant working to stock against a brief but hectic shipping season, a delay cannot well cost more than the pay allowance to make up the lost time by overtime or Sunday work. In all these cases a little study will usually show that the time of many men is indirectly involved. Thus packers, shippers, painters, finishers, and assemblers may be involved in a manufacturing delay that is primarily due to a failure in a raw material or originating department.

All of this does not mean that, since any sort of precision is unattainable, worthwhile results are hopelessly impossible and such a study is useless. Commonly there is so great a difference in the relative showing, everything included, that a sincere attempt to evaluate all of the items in dollars will point unmistakably to one or the other type of drive. The fact that precision is often unattainable in such a comparison does not make the attempt valueless; precision is unnecessary if there is a great contrast in the totals.

Of course there are border-line cases where the costs are a stand-off and it makes little difference which type of drive is chosen.

The principal aim of such a comparative analysis must be not extreme precision in details, but rather a painstaking effort to avoid the tendency to decide offhand on the basis of one advantage or disadvantage—in other words, a determination to include all relevant factors of importance in the comparison.

▼ ▼ ▼

"Out of the dark by Christmas" might be the slogan for the 16-page lighting-painting section of the March issue. Won't be, though, because you won't want to wait till Christmas when you learn why *better light is better sight* and not just the dozen extra foot-candles you always thought it was

Better Light **· March Issue ·** ***Better Sight***

The Variable Budget

1. Principles

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Variable budgets are readily adjustable to changes in business activity, allow for deviations from the expected sales program, give consistent control of expense regardless of load fluctuations

MOST BUDGETS are handicapped by the static results they project. A static budget measures an expected condition at a given extent of activity only. It gives a cross-section of *average* expectancy. However, it loses its effectiveness as a control in direct proportion to the variation of the actual from the budgeted activity. Because of the tremendous changes in industrial activity since 1929, we have developed principles of budgeting that can readily be adjusted to fluctuations in load. We call these newer budgets *variable budgets*.

In our company we have gone even a step further. We not only build the budget based on sales for the coming year; we build a variable budget that allows for deviations from the expected sales program. Still further, we set up an expense control based on the variable budget which gives us a unified and consistent control of expense regardless of the degree of fluctuation in the load. We believe that this control is one of the simplest for the control of manufacturing expense. It is this factor of the variable budget that I present. In treatment, I divide the subject into two parts:

(1) The theory of the variable budget.
(2) The application of the principles determined from the theory.

The first part is considered in this article, the second in an article to be published next month.

A variable budget can be applied to any of the elements that go to make up sales because all of these elements are related to sales themselves. It is the determination of these relationships that makes the variable budget differ from the old static budgets. For the sake of simplicity these articles are confined to the element of manufacturing costs, but with no wish to intimate that successful application of the principles cannot be made to all of the other elements of cost.

Manufacturing expense is, roughly, made up of expenses for:

(1) Indirect or non-productive labor.
(2) Material, such as coal, shop supplies, small tools.
(3) Fixed charges, such as depreciation, taxes, and insurance.

In developing a variable budget of these expenses it is necessary, first, to determine the basic activity responsible for variations in the items under study. It matters little whether this activity is expressed in terms of dollars, hours, men, or machinery. The main point is that the basis of distribution must be one that supports the expenditure of the money involved.

After a base has been determined the next step is to classify the expenses in relation to the base. We use the following two general classifications:

(1) FIXED EXPENSES are those basic expenses necessary in a going concern regardless of the volume of productive activity. They consist of "standby" expenses or "readiness to serve" costs necessary regardless of productivity. Examples: Expenses for taxes, insurance, portions of executives' salaries.

(2) VARIABLE EXPENSES are those basic expenses that have a determinable relationship to productive load. Examples: Expenses for wages of inspectors and helpers, costs of accident insurance, maintenance of machinery.

The procedure of determining the relationship of variable expense to productive load is shown as the *degree of variability*. For example, helpers depend entirely upon the productive load as they arrange material for a productive operator; consequently they are practically 100 per cent variable. Foremen, especially those on a salary basis, are hired to supervise the work of individuals doing productive jobs. They also supervise non-productive labor. Although they depend primarily upon production for a continuation of their jobs, they are not always "hired and fired" as the productive load varies; consequently their extent of variability is much less.

To illustrate the analysis just presented, let us assume that we have 100 productive operators. With these we have a superintendent, two salaried foremen, three hourly foremen, one methods man, three inspectors, ten service employees, two maintenance employees, and nine clerical employees. Applying the principles involved in

Table I. Detailed Budget for Three Conditions of Load

Line	FUNCTION	NO LOAD BASIS		30-HOUR LOAD BASIS				36-HOUR LOAD BASIS								Lines
				Load No. 1 30-Hour Basis				Load No. 2 36-Hour Basis				Load No. 3 36-Hour Basis				
		Actual Fixed at Zero	Theoretical or Math. Fixed at Zero	No. of Emp.	Rate of Pay	Total Hours	$ Take Home	No. of Emp.	Rate of Pay	Total Hours	$ Take Home	No. of Emp.	Rate of Pay	Total Hours	$ Take Home	
1																1
2	Productive Operators			23	$0.50	700	$350	25	$0.50	900	$450	30	$0.50	1,080	$540	2
3				45	0.60	1,350	810	50	0.60	1,800	1,080	60	0.60	2,100	1,260	3
4				22	0.80	660	530	25	0.80	900	720	25	0.80	1,250	1,000	4
5	Total Productive	0	0	90	0.624	2,710	1,690	100	$0.625	3,600	$2,250	125	$0.634	4,430	$2,800	5
6																6
7	Non-Productive Expense															7
8	Labor															8
9	Superintendent	$50	$78	1	.....	.....	$78	1	.....	.....	$78	1	.....	.....	$78	9
10	Salaried Foreman	....	68	2	.....	.....	90	2	.....	.....	96	2	.....	.....	104	10
11	Hourly Foremen	....	30	3	.....	.....	72	3	.....	.....	85	3½	.....	.....	99	11
12	Methods Men	....	....	1	.....	.....	35	1	.....	.....	51	1½	.....	.....	60	12
13	Service Employees															13
14	Helpers			5	.....	.....		5	.....	.....		6	.....	.....		14
15	Stockkeepers	60	60	3	.....	.....	166	3	.....	.....	202	3	.....	.....	237	15
16	Others			2	.....	.....		2	.....	.....		3	.....	.....		16
17	Maintenance	28	28	.....	.....	.....	43	2	.....	.....	48	2	.....	.....	53	17
18	Clerical															18
19	Shop Clerks			3	.....	.....		3	.....	.....		3	.....	.....		19
20	Cost Clerks	30	85	2	.....	.....	240	2	.....	.....	290	2	.....	.....	340	20
21	Other Clerks			3	.....	.....		4	.....	.....		5	.....	.....		21
22	Inspectors	....	....	3	.....	.....	68	3	.....	.....	90	3	.....	.....	112	22
23	Total Non-Prod. Labor	$168	$349	28	.....	.....	$792	31	.....	.....	$940	35	.....	.....	$1,083	23
24	Material & Other Exp.															24
25	Misc. Shop Material	$15	$15	..	.....	.....	$85	...	.....	.....	$105	..	.....	.....	$127	25
26	Power, Heat & Light	47	47	..	.....	.....	307	..	.....	.....	390	..	.....	.....	475	26
27	Other Oper. Expense	.....	.....	..	.....	.....	52	..	.....	.....	68	..	.....	.....	85	27
28	Total Operating Exp.	$230	$411	..	.....	.....	$1,236	31	.....	.....	$1,503	..	.....	.....	$1,770	28
29	Fixed Charges	$706	$706	..	.....	.....	$728	..	.....	.....	$735	..	.....	.....	$742	29
30	Total Manufacturing Exp.	$936	$1,117	28	.....	.....	$1,964	31	.....	.....	$2,238	35	.....	.....	$2,512	30
31	% Non-Prod. Labor to Prod.	Infinite	Infinite	..	.....	.....	47%	..	.....	.....	42%	..	.....	.....	39%	31
32	% Total Mfg. Exp. to Prod.	Infinite	Infinite	..	.....	.....	116%	..	.....	.....	99%	..	.....	.....	90%	32
33																33
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Column

static budgeting, the following would represent a fair budget for this group.

Productive Operators	
25 x 50c. per hour x 36 hr. per week	$ 450
50 x 60c. " " x 36 " " "	1,080
25 x 80c. " " x 36 " " "	720
Total Productive Labor	$2,250
Non-Productive Workers	
1 Superintendent, 40 hr.	78
2 Salaried foremen, 40 hr. each	100
3 Sub-foremen, 36 hr. each @ 80c.	86
1 Methods man, 40 hr.	47
10 Service employees at 50c.-36 hr. each	180
2 Maintenance @ 60c.-40 hr. each	48
9 Clerical (5 salaried)—3 @ 80c.-1 @ 40c.	290
3 Inspectors	75
Total Non-Productive Labor	$904
Miscellaneous	106
Power, Heat, and Light	393
Other Expenses	78
Total Labor	$1,481
Fixed Charges, Depreciation, Taxes, Insurance, etc.	735
Total Manufacturing Expense	$2,216

This budget is satisfactory if our activities remain around $2,250. If our load should be only $1,700, or rise to $2,800, we are not sure what our expenses would be unless we build up a detailed budget at each point. Suppose we do so.

Table I shows these three points of activity supported by expense budgets. When the original budget was compiled, it was based on the assumption that the activities would actually represent $2,250 during the period. It also assumed that the distribution by recording periods (days, weeks, or months) would be proportionate and therefore not subject to great variations. (These are ideal conditions and are seldom realized even if the original estimate is met. It is an unusual business that is able to carry a constant productive load. Based on either or both of those assumptions, it would probably be necessary, before the budgeted period was over, to

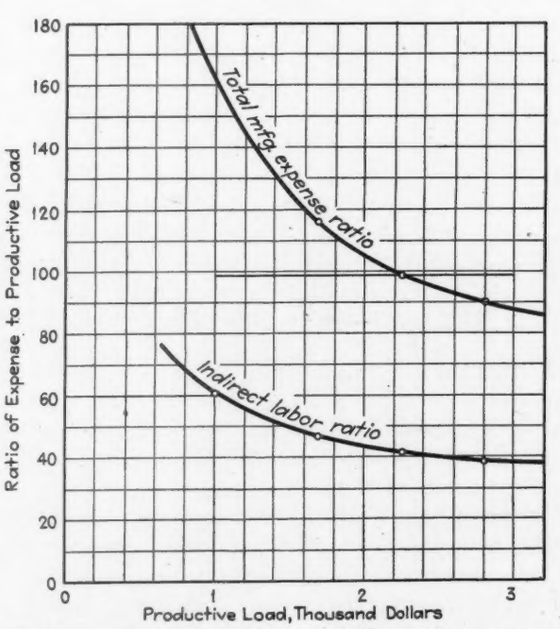


CHART 1—Ratio of expense and indirect labor to productive load

estimate expenses at other volumes, both higher and lower than the original projection.)

Let us assume that when we made the original budget we realized that for adequate control of expense it was necessary to prepare for loads ranging from a low of $1,700 to a high of $2,800 and that we built three static budgets marked "Loads 1, 2, and 3" to cover those three points. We now have actual static budgets for projected low, mean, and high activities during a future period. If we can relate these points we can develop a control that will measure any range of activity between them. Further, it will become possible to relate these specific points to other specific points previously determined or projected into the future. When this is done comparison is possible.

If we study loads 1 and 3 we can develop the necessary technique of relating static budgets. Examination will show differences between most of the corresponding

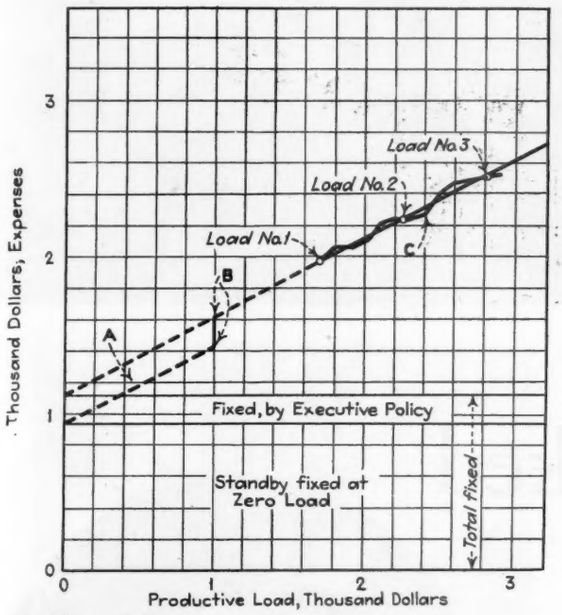


CHART 2—Effect of executive policy

items at the several loads. Except for "Superintendents" all items in load 3 are greater than the corresponding items for loads 2 and 1. The figures show us, in part:

	Load 3	Load 1	Difference
Labor	$1,083	$792	$291
Oper. Exp.	1,770	1,236	534
Total Mfg. Exp.	2,512	1,964	548
Productive Load	$2,800	$1,690	$1,110

In $1,110 of productive load spread, non-productive labor varies $291, operating expenses $534, and total manufacturing expense $548. Expressed in fraction of a dollar per dollar of total expense to productive load, the change equals $548/1,110 or $0.494. If each of the items of expense is treated likewise, a corresponding relationship will be found. For further illustration, notice service employees; at $1,690 load the expense is $166, and at $2,800 load it is $237, an increase of $71. Expressed as a variable, this equals $71/1,110 or $0.0064 per dollar of load. If we follow the same method in calculating all the accounts the combination of the various variables will equal the $0.494 previously given for the total expense.

Reference to Chart 1 shows that as productive load increases the ratio of expense to load decreases. This is only another way of saying that expenses increase less than one dollar per dollar of increase in productive load. In fact we have already shown that expenses increase approximately 50c. per dollar in this study.

The increase of 50c. in expense per dollar of productive load between loads 1, 2, and 3 is shown graphically in Chart 2. The line of slope which passes through these three points is projected beyond the minimum and maximum loads being used. When this line reaches zero, or standby activities, there remain expenses of $1,117.

This condition is contingent upon the assumption that expenses continue to vary at all levels comparable to their average variability between loads 1 and 3. In general this assumption is sound. *Expenses do continue to vary at all levels of activities at approximately the same rate.*

It is not denied, however, that for short spreads of activity actual variability may be substantially greater or less than the over-all average we are using. But for real expense control—a control related to any reasonable productive level—these peaks are of minor importance because they tend to balance out.

The line marked *C* might represent the actual points of budgeted expense at every $100 of productive labor between loads 1 and 3. To control expense in these minute fields or ranges would set up clerical and supervisory effort that probably could not be justified.

By the use of the straight line we get approximately 98 per cent cumulative efficiency with about 10 per cent of the effort. This leads us to a fundamental conclusion: *The determination of points of activity on which variability should be determined should be limited to a few representative points.*

A definite attempt should be made to pick those points at which policy changes might be expected to occur. The determination of an average variable between loads 1 and 3 does not present any serious problem. However, the extension of the variable below actual minimum working loads may present problems.

Referring again to Table I, we find that column C shows the $1,117 of fixed expense we have just spoken about. This represents the expense that would be left at zero or standby activities if variations at all loads were the same as the variations between loads 1 and 3, i. e., 50c. per dollar of productive load.

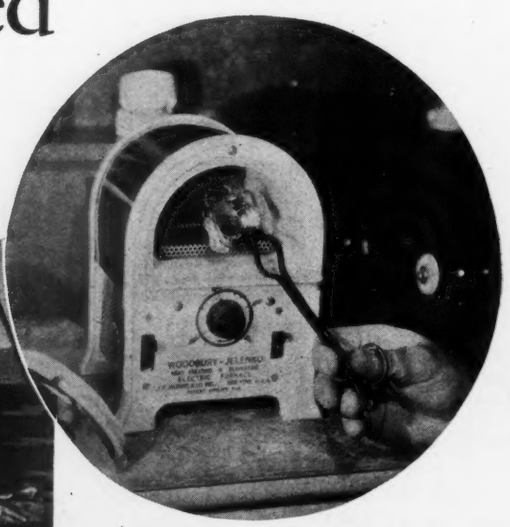
However, if we made a study of the actual expected expense at zero or standby productive load, we no doubt should have an amount smaller than $1,117. In this study this amount is $936 (see column B). *The difference between the fixed or zero of $1,117 and that of $936 represents conditions expressed by managerial policy.* Just where these policies may actually find expression is problematical. The urgency of the times no doubt will dictate. The point is that, by setting them in your plan at a reasonable point of expectancy, you acknowledge them and insure definite consideration.

(Continued on advertising page 34)

STEEL. It no longer takes hours to heat rolls to proper temperatures. Electric units preheat spare sets of rolls and keep them at operating temperatures, thereby permitting frequent changes without loss of time, increasing first-turn tonnage from 4,000 to 5,000 pounds, and cutting scrap metal loss about 10 per cent

SPORTING GOODS. Dunlop Tire & Rubber Company, Buffalo, trade-marks tennis balls with a machine that has a 275-watt cartridge-type heating unit

These Plants Picked Electric Heat

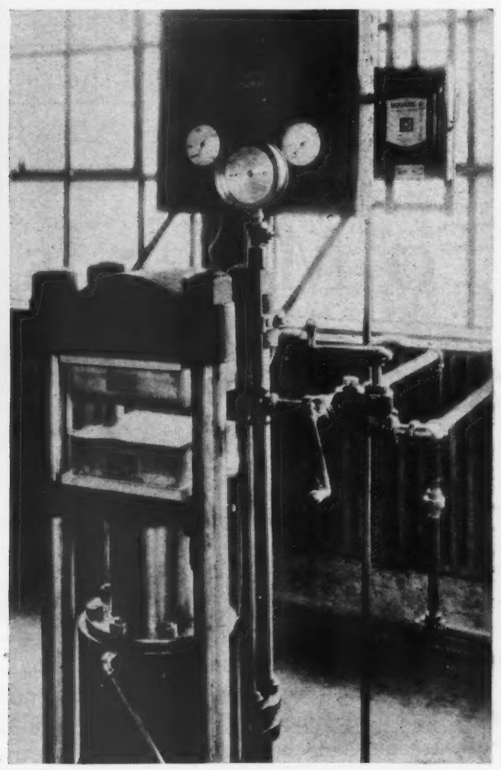


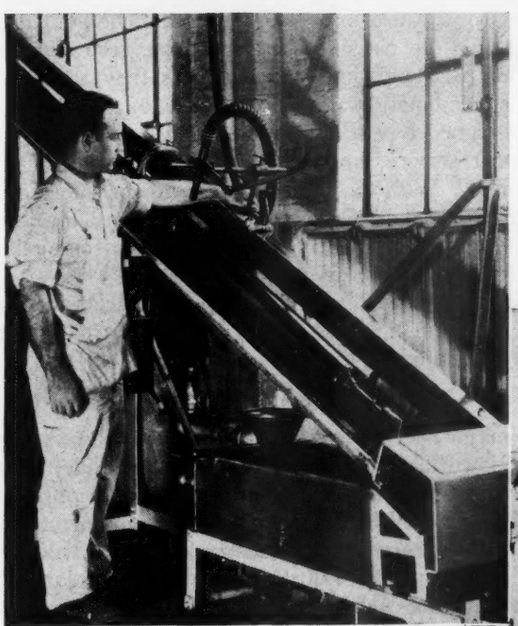
DENTAL INLAYS. It seems you heat-treat gold, just as you heat-treat steel, to get various degrees of hardness. Important because eating puts considerable pressure on dental parts and sometimes changes the general shape of an inlay or bridge

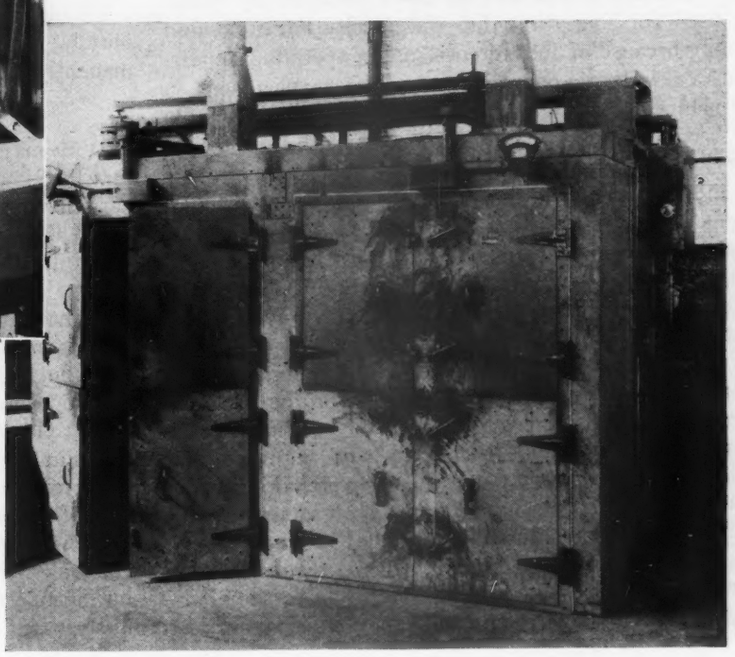
FOOD. Electric heat is admirably suited to putting up preserves in limited quantities. There are 40 electrically heated pans in this production line, each with a three-heat switch for quick control

RADIOS. To melt insulating compound fast enough to keep up with rapidly moving production lines and to keep it at automatically controlled temperature, a radio plant uses a battery of fifteen 40-qt. electrically heated pots. The arrow points to a pouring ladle, likewise electrically heated

PLASTICS. Electrically heated platens mounted in a standard hydraulic press with separate temperature controls for the upper and lower units







PRINTING. Two 1,000-watt immersion heaters are installed in this machine used to coat printing press rollers

BRAKE LININGS. A manufacturer of asbestos products uses a two-compartment electrically heated oven. Either the upper or lower compartment can be loaded or unloaded without interrupting the bake in the other. Its air circulating system insures uniform temperatures

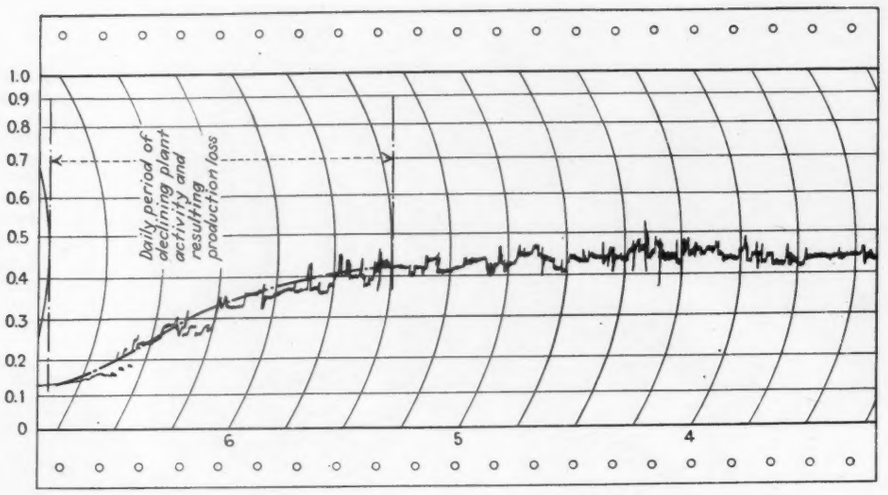


Figure 1. Late starting, early stopping, of operators make the plant load curve and the production records look bad

To Meter Is to Know and Save

Ottomar H. Henschel
Sando, Geerlings and Henschel, Engineers
Milwaukee, Wis.

MANY industrial executives probably regard the metering of electrical energy, steam, gas, air, or water as the fancy of some more or less progressive engineer, rather than as the means by which departmental or other unit charges may be properly allocated, production costs determined, wastes detected.

This attitude frequently may be well-founded. Possibly at some time the management was induced to purchase metering equipment, and then heard no more of it. The equipment was no doubt installed and properly used for some time, but the novelty wore off, and possibly because of indifference of the operating department, or lack of cooperation by the management, a well-planned program with its resulting potential benefits had been discarded. As a consequence, the subject of metering has tended to be regarded with skepticism, if not indifference, by those whom it would, and should, benefit most.

Like any other machine, a meter must be used intelligently and consistently to perform a specific duty. The facts revealed will give the plant executive information inestimable in value if actually put to work.

Fundamentally, metering is a means to an end. It should not be attempted promiscuously or for the mere sake of metering. The object for doing so must exist. It may be to determine the extent and nature of the load upon, or the power factor of, an electrical device, or of a whole industrial plant; it may be to determine the loading or the rate of evaporation of a steam boiler. Again, the object may be to secure cost of electrical energy, steam, gas, and so on, chargeable to some particular factory department or manufacturing process.

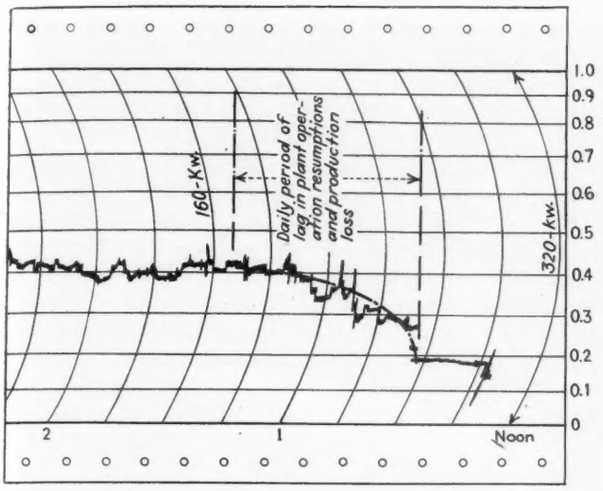
Meters for the measurement of electrical energy, gases, or fluids may be classified as indicating, recording, or integrating, although in many instances they are available in a combination of two or more of these types. The first-named type is the simplest and is employed for intermittent service, or where continuous readings are not required. With the recording instrument some form of record is available, whereas with the third, or integrating type, readings of the sum total of the commodity being measured are provided.

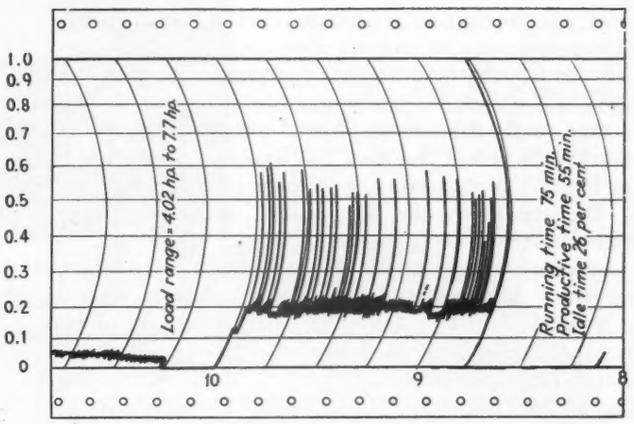
From another standpoint meters may be classified as portable, used in field testing, and switchboard or permanently mounted types.

Stories the Meters Tell

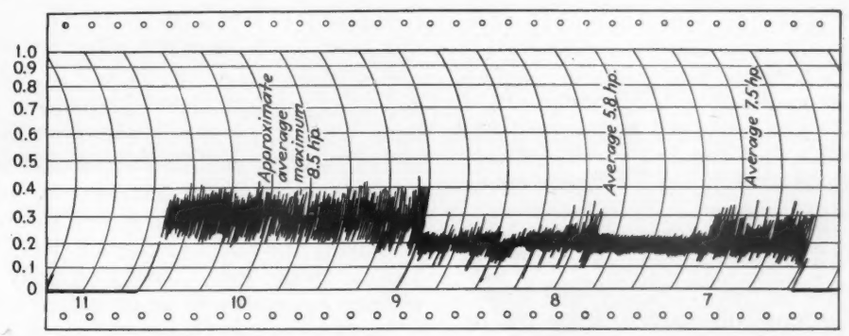
With major operations dependent upon machine rather than hand work, plant activity is invariably reflected in variations in electrical energy requirements and consumption. Figure 1 illustrates the size and characteristics of the load in a wooden box factory between 12:30 and 6 p.m. on a typical day. Contrary to general belief, this chart pictures what happens daily in many plants.

It is apparent that, despite appearances, production does not get into full swing immediately upon return of the operators in the morning and after each shutdown; plant activity has a decided tendency to lag from 15 minutes to an hour or more. A similar, perhaps more marked, tendency is usually in evidence toward the end of the day when operators begin to stop work as much as an hour and a half before quitting time. Naturally, this tendency may be due largely to fatigue, but it may be fostered by laxity in supervision. In many cases it is possible to detect these conditions only

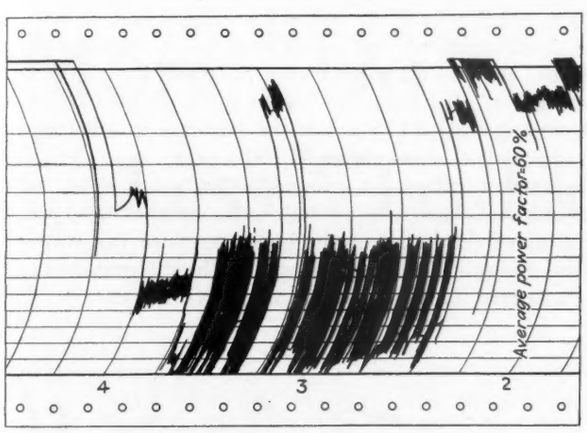


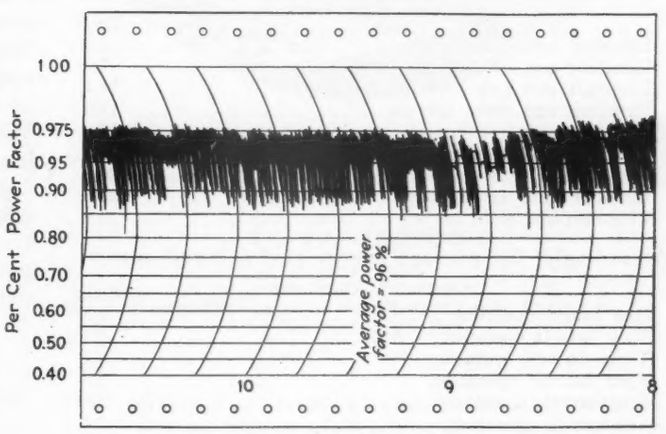


ABOVE
Figure 2. A wattmeter chart showed what no one suspected—that a large power press was loafing 26 per cent of the time. Simple changes in routine raised the production time to 95 per cent



RIGHT
Figure 3. Charts like this one made it possible to save $96 a year, 30.8 per cent, in the cost of power required in the cleaning room of a malleable iron foundry





Figures 4 and 5. There's a difference of $1,237 a year between these charts, which were taken before and after raising the power factor of a plant from 60 per cent to 96 per cent

by metering the electrical energy supplied to the plant or the department under surveillance.

In this particular instance the lag in resuming operation and the periods of declining activity extend over, say, five hours each day. Proper interpretation of the chart will reveal a net actual loss of perhaps 1½ hours. In a 9-hr. day, this loss represents 16 per cent.

The plant has an average of 40 employees, each receiving a base rate of 45c. an hour; so the daily loss to the company is 1.5 times 40 times 45c. = $27. In a 300-working-day year, the loss will be $8,100. Obviously, the human element, nature of operations, production schedules, and so on, preclude entire elimination of the loss. However, experience indicates possible reductions of at least 60 per cent. Hence, in this case a saving of at least $4,860 is in sight.

Survey and detailed analysis of conditions existing within the plant will assist greatly in the correction of apparently inherent difficulties. Figure 2 shows the characteristics of the load on a 10-hp. slip-ring motor belted to a power press handling a fairly heavy drawing job. As shown, during an operating period of 75 minutes the productive time was only 55 minutes. Idle periods totaled 20 minutes; so 26 per cent of the time was nonproductive.

Investigation showed that during the idle periods the press crew had been waiting for stock. When this condition was remedied, the productive time was raised to an average of 95 per cent. Recovery of 21 per cent of the lost time, with a labor charge of $1.10 an hour, stopped a loss of $2.08 a day, or $624 a year.

In another plant the machine-shop load was being

checked by means of a portable wattmeter. The plant was working under a 24-hr. schedule, and in order to avoid interruption to production, orders were issued to operate without a lunch-hour shutdown.

From the charts it became apparent that from midnight to 1 o'clock no power was being consumed. Confronted with the records, the foreman admitted that contrary to orders the men had knocked off each night for lunch. With a crew of 20 men at an average wage of 70c. an hour, the loss would have amounted to approximately $4,000 a year.

Another incident shows the dollars-and-cents value of metering. Load records were taken in the cleaning room of a malleable iron foundry on a unit consisting of eight 3x4-ft. tumbling barrels driven by a 25-hp., 1,200-r.p.m., squirrel-cage induction motor from a 48-ft. lineshaft. The power factor was 50 per cent. Interpretation of a typical load record, Figure 3, revealed these facts:

	Horsepower
Load of three barrels and lineshaft	6.1
Load of one barrel and lineshaft	3.7
Load of two barrels only	2.4
Load of one barrel only	1.2
Load of lineshaft	2.5
Load of eight barrels	9.6
Load of eight barrels and lineshaft	12.1
Actual horsepower at 80% motor efficiency	9.7
Rated motor horsepower actually required	12½ or 15.0

The average cost of energy was 2.87c. a kilowatt-hour; so the hourly cost of operating the barrels appeared to be:

	Cents
Lineshaft only	5.3
Lineshaft and one barrel	7.9
Lineshaft and two barrels	10.4
Lineshaft and three barrels	13.0
Lineshaft and four barrels	15.6
Lineshaft and five barrels	18.2
Lineshaft and six barrels	20.7
Lineshaft and seven barrels	23.3
Lineshaft and eight barrels	25.9

Accordingly, the average energy cost a barrel was:

	Cents
One barrel operating	7.9
Two barrels operating	5.2
Three barrels operating	4.4
Four barrels operating	3.9
Five barrels operating	3.6
Six barrels operating	3.4
Seven barrels operating	3.3
Eight barrels operating	3.2

Further analysis proved interesting. Assuming that two barrels were operated practically continuously throughout a 10-hr. day, giving 20 barrel-hours, the energy cost a barrel an hour is equal to 5.2c., or for the two barrels, 2 times $0.052 times 10 = $1.04 a day. For a 300-day year it amounts to $312. Tests were then conducted and it was found possible to operate these 20 barrel-hours by using five barrels four hours daily. Then, since the energy cost a barrel-hour, when operating five barrels simultaneously, was equal to 3.6c., the total energy cost for the five barrels for four hours' operation was 72c., or $216 for a 300-day year.

The result of taking advantage of these findings was that the yearly energy cost was reduced $96 or 30.8 per cent. Incidentally, a 15-hp. motor replaced the original 25-hp. unit, increasing efficiency and power factor.

Where electrical energy is purchased under a contract embodying power factor penalty or bonus clauses, it is desirable that high power factor be maintained. Continuous metering will help to accomplish this end by showing the value of, and variations in, the system power factor. Figures 4 and 5 illustrate power factor values of a typical industrial plant before and after correction. The financial results of such corrections may be shown through a comparison of billings to the consumer employing in one instance the original power factor and in the other the improved power factor. For this purpose identical demands and consumptions have been used. Under an average monthly power factor of 60 per cent, the net bill for a consumption of 63,000 kilowatt-hours was $935.69.

After the system power factor had been raised to 96 per cent, and under like conditions of demand and consumption, the net billing was $832.58. Therefore, the savings amounted to $103.11 a month, or $1,237 a year.

Boiler Steam Flow Metering

The performance of a boiler and the cost of steam can be ascertained only by weighing or measuring the fuel, and metering the steam. Obviously, too, it is only by metering the steam delivered that it becomes possible to detect increases or decreases in operating efficiency.

In Figure 6 is shown a typical steam flow meter chart portraying the size and characteristics of the load on a 150-hp. water-tube boiler formerly hand-fired, but recently equipped with an underfeed type of stoker.

Previous to this change the average rate of evaporation was but 7 pounds of steam for each pound of coal. Since installation of the stoker and more attention to operation, the rate of evaporation has been increased to an average of 10.4 pound of steam for a pound of coal. With fuel costing $4.75 a ton the increase in efficiency has reduced fuel costs about $3,100 a year.

The instrument which produced this chart is of the combined indicating, recording, and integrating type. By means of the indicator the boiler operator can watch the load and quickly detect changes. The integrator provides accurate daily records of the performance.

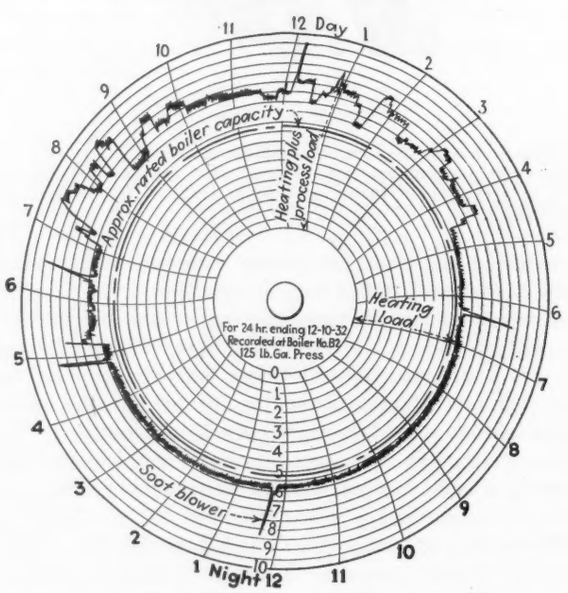
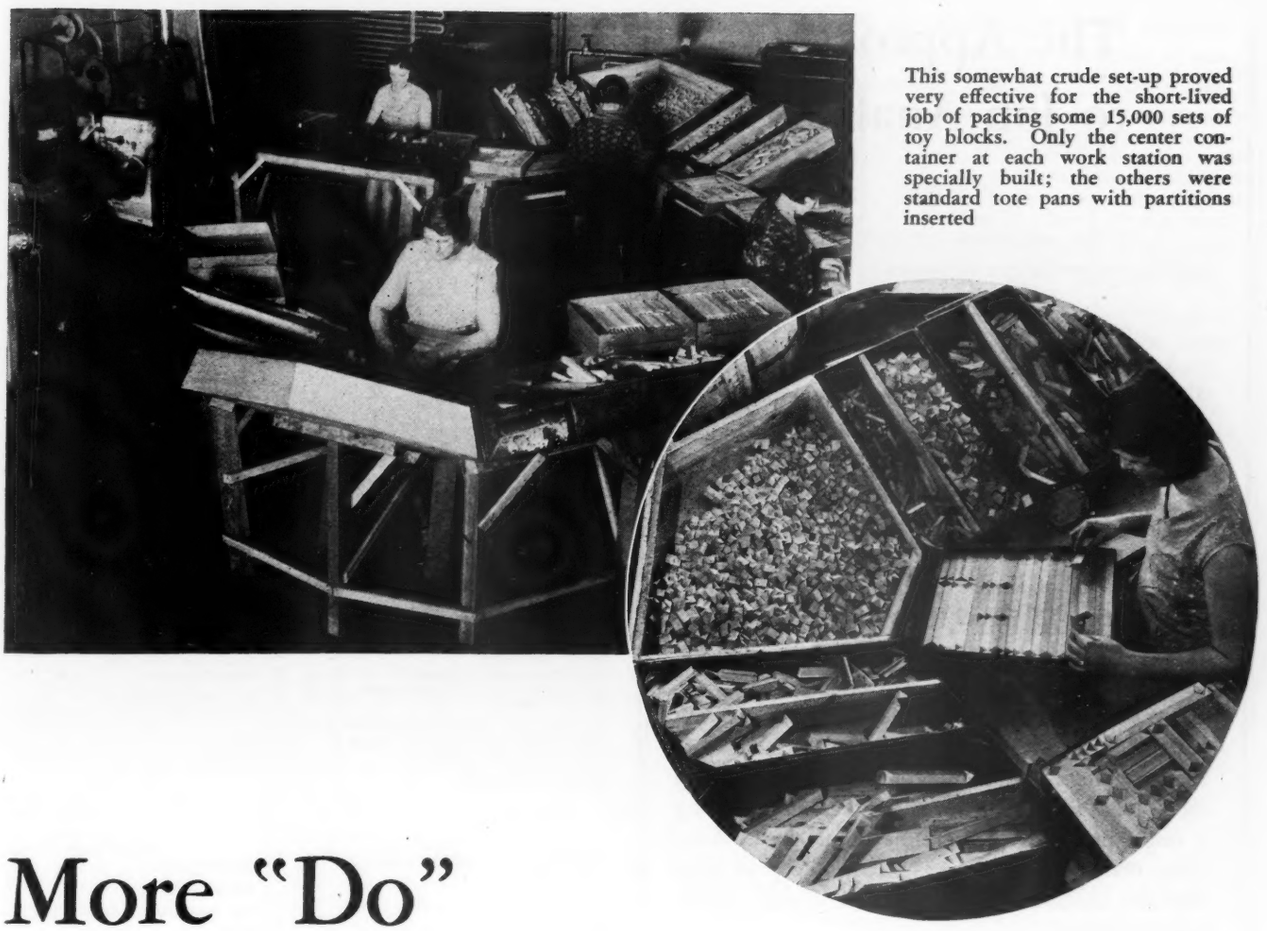


Figure 6. No guesswork about boiler performance, with a flowmeter on the job.



This somewhat crude set-up proved very effective for the short-lived job of packing some 15,000 sets of toy blocks. Only the center container at each work station was specially built; the others were standard tote pans with partitions inserted

More "Do" Less "To-Do"

C. G. Johnson

Time Study Department
Westinghouse Electric and Manufacturing Company
East Pittsburgh, Pa.

WHAT IS motion study? The name itself has aroused antagonism numerous times and for this reason we now speak of job analysis incorporating the principles of motion economy. Basically that defines motion study and it differs from past practice only by making a more thorough analysis of each job than was previously thought necessary.

Some have thought motion study to be a new method of time study, and time and time again the question has been brought up regarding its relation to time study. This latter question has been ably answered a number of times—job analysis and time study are inseparable. Every time-study man should be grounded in the fundamental principles of motion economy. Watch readers are out. The analyst is here to stay.

To arouse interest in, and further the cause of, job analysis we have employed methods similar to those described in previous articles in *Factory Management and Maintenance*. Papers on the subject have been prepared and distributed among various supervisors. Motion picture equipment was purchased, and pictures were taken of jobs before and after improvement. These pictures have been shown at supervisory meetings and to groups of workmen, and they are always available for use by any member of the organization who is interested.

New moving pictures of jobs "before" and "after" are being taken continually and presented at supervisory meetings. This permits an interchange of ideas between departments and makes each additional application simpler by incorporating principles that have been previously developed. Any information that can be secured regarding motion study is distributed to all interested parties.

The process chart is an important unit of job analysis procedure. On his first few jobs the beginner is advised to make complete charts, such as is shown in Figure 1. Here the arrangement of the material and the movements made by each hand are shown for both the old and new method of assembling an arc shield. The chart of the old method shows clearly the idle time, holding time, and unnecessary operations. It is also very ap-

The Approach to Job Analysis

1. Is the operation necessary? Could it be entirely or partially eliminated?

•

2. If more than one operator is working on the same job, are they all using the same method? Why not analyze all the different methods and make a "one best method" from the data?

•

3. Is the operator comfortable? Sitting down as much as possible? Does the stool or chair being used have a comfortable back? Is the lighting good but not glaring? Is the temperature of the work station all right? No drafts? Are there arm rests for the operator?

•

4. Can a fixture be used? Are the position and height of the fixture correct? Is the fixture the best one available? Would a fixture holding more than one piece be better than one holding a single piece? Can the same fixture be used for more than one operation? Always keep in mind that the human hand makes a very poor clamp, vise or fixture.

•

5. Are any semi-automatic tools applicable? For example, a power-driven wrench or screwdriver, or a Yankee socket wrench or screwdriver?

•

6. Is the operator using both hands all the time? If so, are the operations symmetrical? Wherever possible, both hands should be in

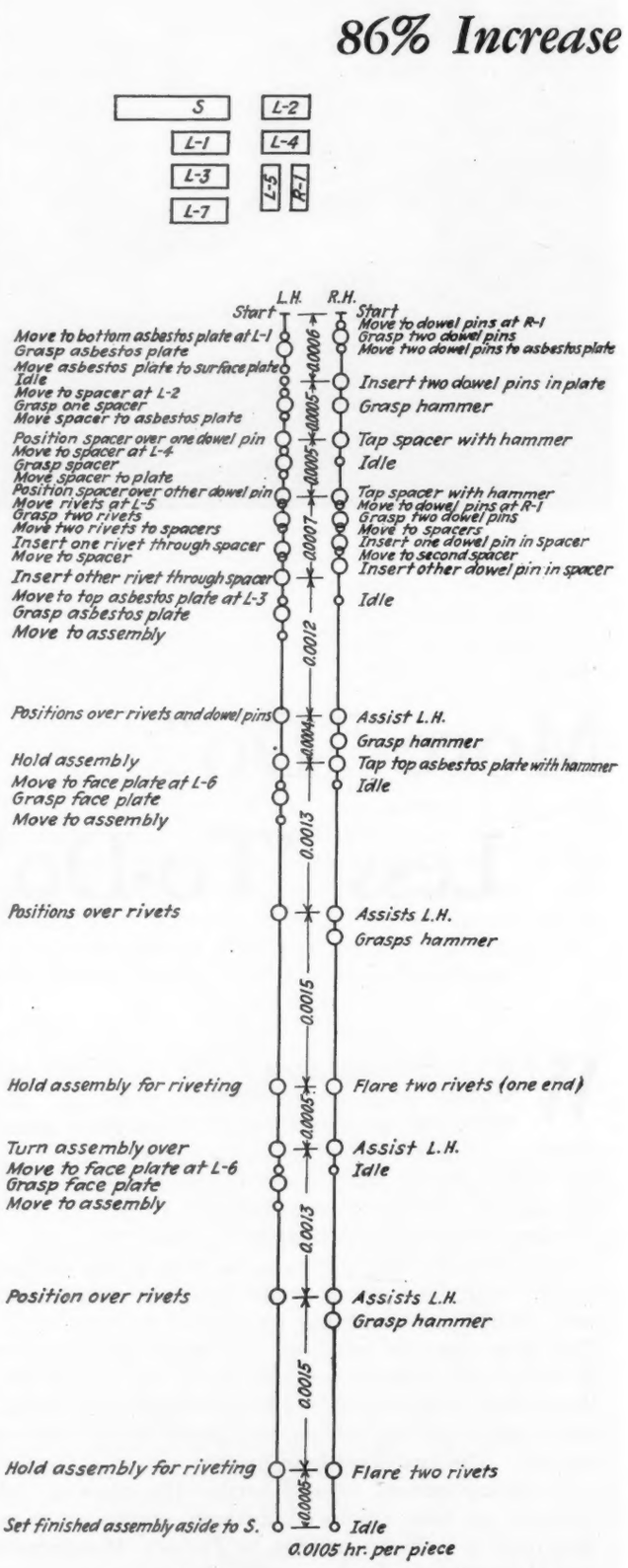


Figure 1. A complete process chart showing (left) old set-up with unbalanced motions, and (right) present procedure which very nearly doubles production

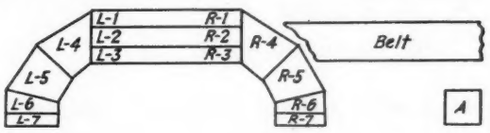
parent that the motions of the two hands are unbalanced.

The results of the improvements made are illustrated in the chart of the new method. The operations are symmetrical and in opposite directions. Both hands are fully occupied on productive work, resulting in an 86 per cent increase in production.

Charts less elaborate than the one illustrated are made as the analyst becomes thoroughly grounded in the principles of job analysis. The simpler charts have been found to be entirely satisfactory.

The two photographs on page 67 illustrate a crude but effective set-up for packing a toy block set. The equipment was designed and accurate estimates of the packing cost were made before manufacture of the blocks was begun. This was a type of job new to our

in Production



motion and moving simultaneously in opposite directions. Could two pieces be handled at one time to better advantage than one? Could a foot device be arranged so that an operation now performed by hand could be done by foot?

•

7. Are the raw materials placed to the best advantage? Are there racks for pans of material and containers for smaller parts? Can the parts be removed from the containers with ease? Are the most frequently used parts placed in the most convenient location? Remember, the shorter the distance moved, the less the time will be.

•

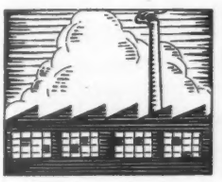
8. Are the handling equipment and methods sufficient? Would a roller or belt conveyor improve conditions? Could the parts be placed aside by means of a chute. Drop delivery is always desirable where possible.

•

9. Is the design of the apparatus the best from the viewpoint of the workman? Could the design be changed to facilitate machining or assembly without affecting the mechanical or electrical qualities of the apparatus?

•

10. Is the job on the proper machine? Are the correct feeds and speeds being used? Are the specified tolerances all right for the use to which the part is to be put? Is the material being used the best for the job? Could one operator run two or more machines?



plants, so the packing benches had to be constructed upon the known principles of job analysis and not by comparison with another similar job. The job was short-lived, so the equipment was necessarily inexpensive. As previously stated, though, the appearance did not lessen the effectiveness of the operation. This well illustrates the point that all motion economy installations need not be expensive. Certain fundamental principles can be applied to temporary and short-run jobs, effecting tremendous savings.

It is hoped eventually to have every job in our plant performed according to the principles of motion economy. This cannot be accomplished overnight, but by subjecting every new job to a thorough analysis and by gradually improving old jobs it will finally be done.

How Big

S. A. Weart

Industrial Engineer, New York

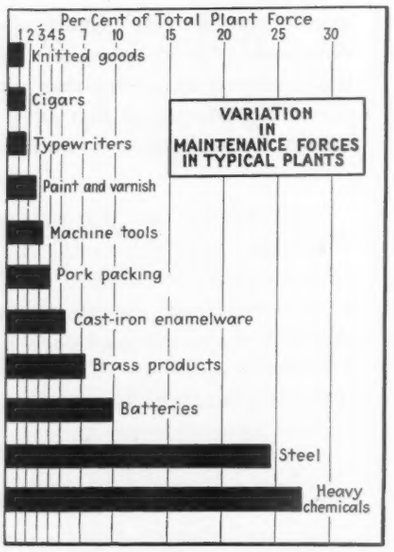


Figure 1. What's your product? Here's your chance to check your maintenance department for size against ratios that obtain in typical well-regulated plants

MAINTENANCE expense may be budgeted, control measures instituted to regulate repair costs. To be successful, however, every budget and every control unit must be based upon a solid foundation —the knowledge of what is the correct size for a maintenance department.

There are many factors causing wide variations in maintenance expenditures among different plants. Process plants with their maze of piping and machinery, where every breakdown means a serious loss, have large crews; shirt factories, with little equipment, and where only one worker is inconvenienced if a sewing machine breaks down, have few maintenance men. Figure 1 shows the variation in size of maintenance forces for typical well-operated plants in several industries. Only repair departments are included; not the allied functions of trucking, watchman service, etc.

Within the same industry there are many good reasons why forces should vary. A modern, well-planned group of buildings presents a different problem from a maze of old and scattered sheds. Machinery that is regularly inspected, oiled, and adjusted requires fewer major repairs than 30-year-old relics which never have received consistent attention. Some executives take pride in their factories and insist upon frequent repairs and repainting; some, driven by financial stringency, deliberately adopt, for the sake of short-lived savings, the policy of permitting no expenditures that may conceivably be avoided. For his own set of circumstances each manager may well be right, but his attitude will very materially alter the size of the maintenance department.

Maintenance work is maintenance work, and one plant or industry presents problems varying only in degree—not in kind—from all other plants or industries. Eventually, as business becomes more standardized, it may be possible to evaluate the many variables that necessitate forces of different size and so arrive at a scientific basis for establishing a correct ratio. At present, recourse must be had to more practical methods.

In making any analysis it is important to have a background of past performance. For an analysis of maintenance forces the background is the plant and company as a whole, layout, machinery and building age and state of repair, relative importance of production delays caused by breakdowns, practices in respect to new construction, and policies as to repairs and new equipment.

Past performances can be judged best from a few basic facts: First, relative proportion of "rush" jobs to regular jobs—too many obviously indicating a lack of preventive maintenance; second, number and size of jobs on the average schedule of work ahead—a schedule with few jobs offering temptation to "make" work for too large a force, and an overloaded schedule being an indication of too few workers; and third, general character of the work—average number of jobs finished daily, largest jobs handled without a temporary increase in forces, and percentage completed without interruption.

Generally there is no reason why, over a long period, expenditures for maintenance should not conform to the rate of production activity. A plotting of maintenance expense (preferably man-hours) against production activity (in tons, man-hours, pieces, or other units) will prove interesting. In Figure 2 the dotted line indicates a plant in which no attempt is made to budget maintenance expense, and the lower solid line a plant in which full advantage has been taken of control measures. While the lag between maintenance and production may vary in different companies, the close degree of conformity between the lower maintenance curve and production curve is not at all unusual.

With a proper background, it is then possible to proceed intelligently with the analysis.

Organization—Good maintenance work requires coordination of all allied activities, which can best be obtained by a single control centralized in one person, the plant engineer or master mechanic, as he may variously be called. The position is of sufficient importance to warrant reporting directly to the chief manufacturing executive. In addition to the millwrights, machinists, electricians, masons, and repair trades proper, the watchmen, sweepers, firemen, and yard force often report to the plant engineer. While in some plants this is advisable, and in others not, it is distinctly essential that all repair trades should have one common superior.

The division of authority under the plant engineer is determined solely by the number in each group. Each requires a foreman, either full-time or working, and large groups will require assistant foremen. Little maintenance work is routine, so the percentage of supervision needed is high, but should not be carried to absurd lengths by a minute division of responsibility.

Repair Shops—The shortest distance to all parts of the factory from any one point is from the center. As near to the center as practicable is the ideal location for

and How Good Is Your Maintenance Force?

maintenance headquarters. Scattered, isolated shops are conducive to poor coordination and bad supervision. Figure 3 illustrates a badly decentralized set of maintenance shops and how they were consolidated.

Equipment and working conditions of repair shops are fully as important as in production departments. Workers, whether maintenance men or on an assembly line, can do their best only when furnished good tools and good working conditions. Minimum maintenance expense is dependent upon having shops equipped with all necessary power saws, brakes, lathes, drill presses, and other machine tools, and upon supplying such portable equipment as electric drills and crane trucks.

Supply Storerooms—The principles which apply to the handling of production stores apply with almost equal force to the control of maintenance supplies. Obviously, the storeroom should be kept locked and material issued only on requisition. The location should be central, adjacent to the repair shops. Inventories may be kept at a low level by careful purchasing, coupled with a definite knowledge of time required to procure important spare parts. Establishment of order quantities and minimums is simple if material for large jobs is ordered separately.

Order Routines—A smoothly operating order system stops unnecessary maintenance expenditures at their source. A multi-copy order to replace a fuse, countersigned by three executives, is a ridiculous bit of red tape; the delineation between work which may be done without an order, and that which may not, is clearly marked in well-operated plants.

The procurement of competitive bids from outside contractors is made compulsory on major construction jobs. Good practice requires estimating costs of at least the larger jobs prior to starting work—and (which is important) a check later on against actual costs.

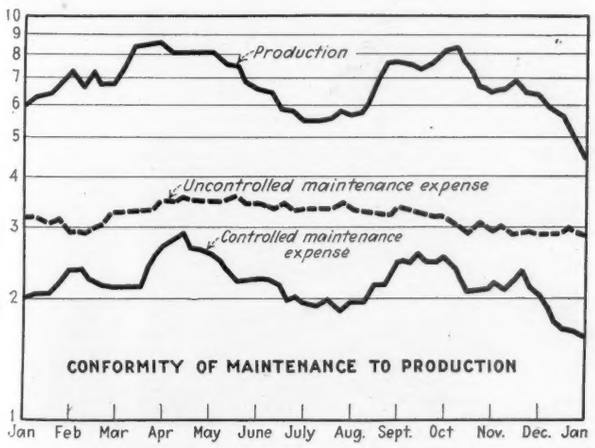


Figure 2. Typical curves to show how maintenance expense may conform closely to production activity and what happens to it when it is not controlled

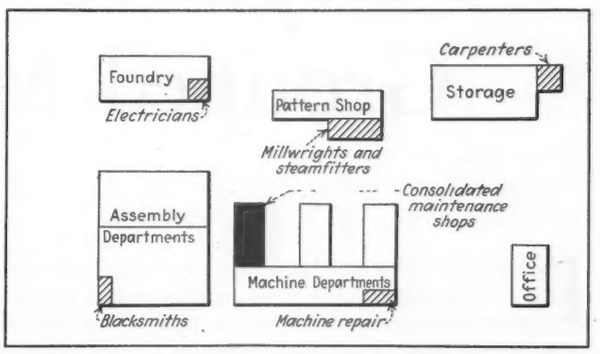


Figure 3. Before and after a manufacturer "got religion" and saw the wisdom of centralizing his maintenance shops. Shaded areas show the scattered arrangement before consolidation into the single unit shown in solid black

A central dispatch system for assigning jobs to workers, with continual knowledge of "jobs working" and "jobs ahead," and a rigid accounting of labor hours, will assist in reducing labor expense.

Layouts and Records—Layout drawings of sewers, piping, and electrical mains are not useless frills. They are a direct means of saving uncounted hours wasted in tracing circuits. Piping painted in a standard color scheme, and coded motors and junction boxes save maintenance labor and many hours of idle production time. A record of major repairs often shows up excessive repair costs and indicates time for replacements.

Inspection—The thoroughness with which periodical inspections of machinery and buildings are made, is often the measure of the difference between "repair" and "preventive" maintenance. The former costs much, directly and indirectly; the latter, little. Minor adjustments can be made during inspections which may forestall major repairs later. To be of value, inspections must be regular as to intervals and items.

Once satisfied that the basic functions are correct in principle and application, a searching analysis of each maintenance division will be simple. If production operators are used during their idle time for repairs, if as many maintenance men as possible are of "helper" rather than "journeyman" grade, if job-time records consistently reveal that excessive times are not required, each group may be considered as operating efficiently.

With the detailed analysis studied in its proper relation to the background of plant conditions and policies, a correct standard maintenance force may be established. Here, then, is the foundation for a successful budgetary control of maintenance expense.

Eleven production lines run in greater safety, with fewer and shorter delays, at lower maintenance cost—since

We Replaced and Grouped Motor Controls

John Fedosky, Jr.

General Manufacturing Department
Continental Can Company

IN PLANTS that employ a large amount of automatic control equipment for small motors, delays and confusion sometimes result from lack of system and order in the location of such controls. Therefore when rehabilitating our Clearing, Ill., plant care was taken to avoid this situation by grouping all controls in panels located in the respective production lines.

Since the manufacture of cans is almost entirely a series of automatic processes, many motors are required for operating machines, conveying equipment, exhaust systems, and the like, and each motor must be equipped with its individual control.

In order to increase production, one section of this plant was completely rehabilitated. Some of the old equipment, including machinery, motors, and controls, was revamped to fit the new plans; other items were moved to some other part of the plant; some were scrapped.

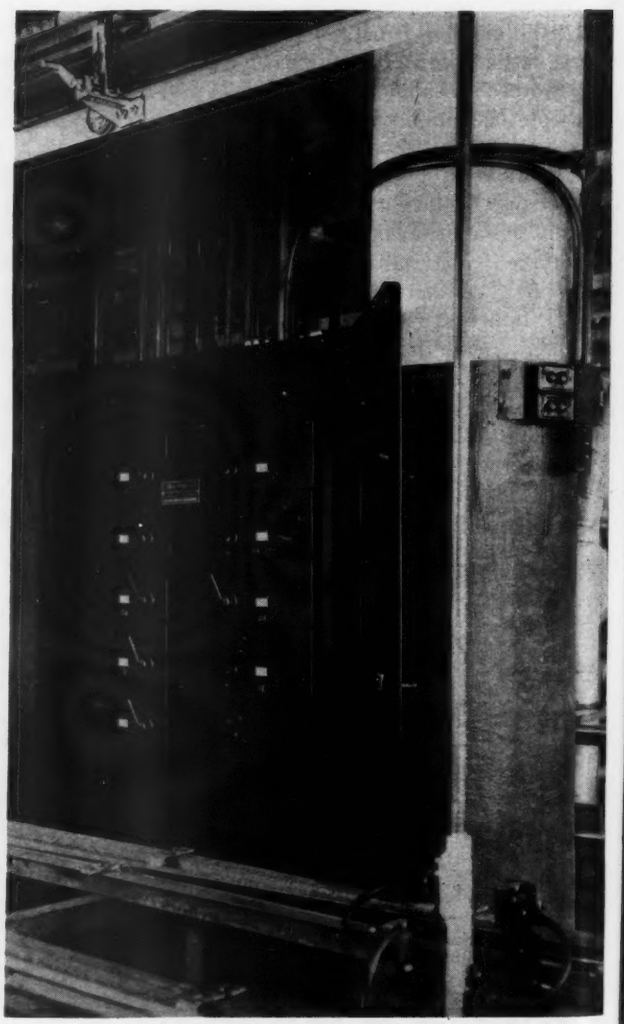
All motor controls were taken down from the walls and posts and off the machine frames and, wherever possible, they are being used in other parts of the plant. Motors that were efficient and served the purpose were retained. Some new motors had to be purchased and an entirely new line of starters was designed and installed.

The latest type of equipment was substituted for the obsolete machines, and eleven lines were laid out for the manufacture of cans. Ten of these lines are now in production with a total capacity of approximately 3,250 cans a minute.

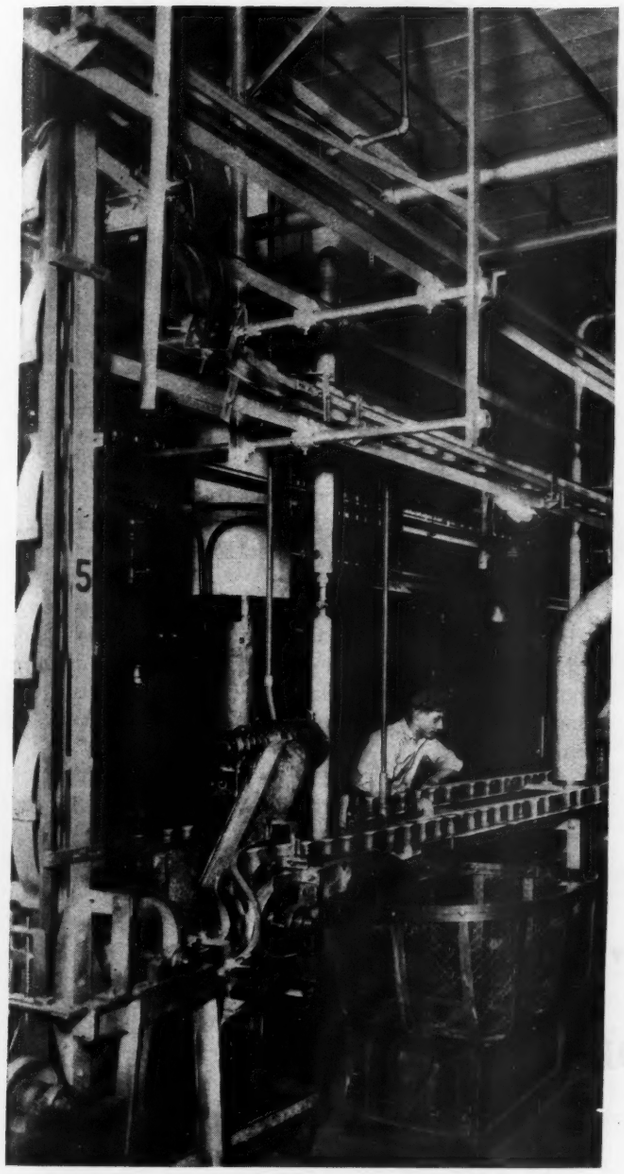
Each production line consists of a body maker, two punchpresses, two headers, and a crimper, all located on one floor. A floater, wiper, and two testers are located on the floor below, with the necessary elevators, cables, and belts to convey parts from one machine to the next. Each piece of conveying equipment has its individual motor, and each machine has from one to four motors, depending on its type and function. These motors range in size up to 7½-hp. rating.

That portion of the line located on the upper floor is also equipped with an exhaust system to carry away heated air and fumes from the soldering operation. There is one exhaust fan for each three or four lines. Two motors are also required for a cooling system.

Motors operating the exhaust fans, cooling system,



Grouping motor controls in a locked cabinet accessible to authorized persons only, protects men and machines. There is one cabinet and panel like this for each production line *(Photographs courtesy of Allen-Bradley Company)*



At the head of one of the can production lines. The cabinet containing the starter panel for this line is just behind the operator

production machines, and conveying systems are controlled by starters located in the panels in each line. Each starter, in turn, is controlled by a Start-Stop pushbutton located conveniently to the machine under control. Each panel is laid out for fourteen circuits, including several spares. Whenever additional starters and circuits are necessary, they can be accommodated in these spare spaces.

All the motor control equipment was grouped on panels inclosed in sheet-metal cabinets. There is one such panel in each production line and this panel contains the starters for all motors in that line. Each starter is clearly marked, so that there is no trouble or delay in finding the starter which controls any one of the motors. A complete wiring diagram for each panel is mounted inside the door.

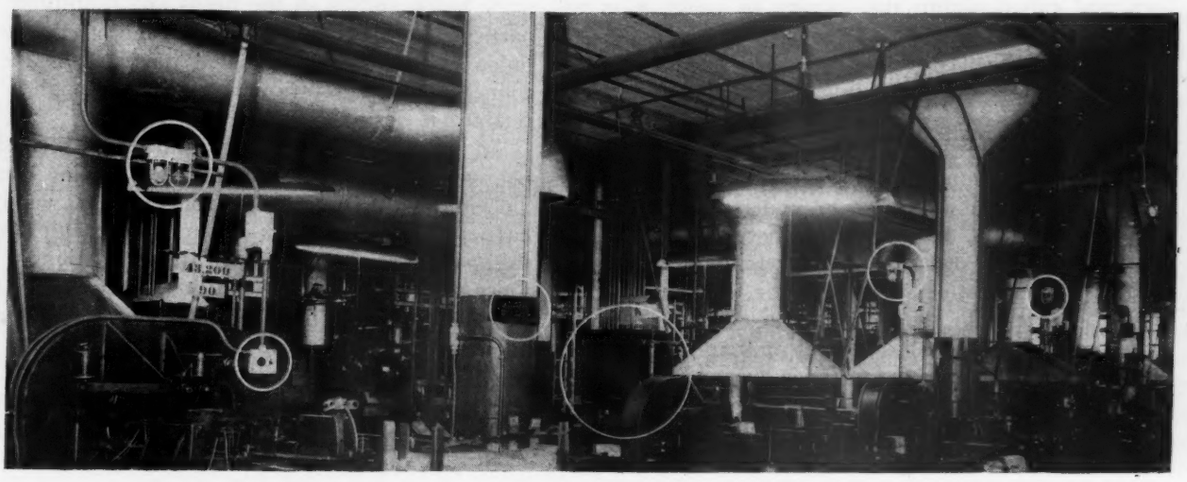
Furthermore, the standardization of these controls has reduced the number of spare parts and fuses that must be carried in stock and has greatly simplified the maintenance problem.

Safety considerations also entered into the decision to employ inclosed starters grouped into panels. Every starter is equipped with a hand-operated switch in addition to the pushbuttons. Each individual starter is also totally inclosed, with the handle of the manually operated switch outside the inclosure. Thus protection is afforded against exposed terminals and other live parts.

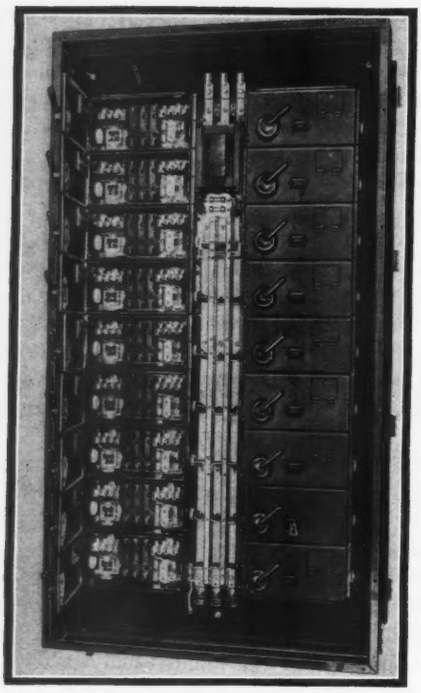
Opening the doors of the cabinet exposes the panel and makes accessible the fourteen hand levers, each of which controls the manual disconnect switch in one of the fourteen circuits. A glance shows which circuits are On and which are Off. Unless the lever for any motor circuit is in the On position, the motor cannot be started, since the pushbutton circuit is rendered ineffective.

Each switch has overload protection. If the overload relay trips out, an indication is given by a visual signal on the switch panel and the motor cannot be operated even though the Start button be pressed. To reset the overload relay, the switch handle is moved to the reset position; then by moving the handle back to the On position the starter is made ready for operation from the pushbutton station.

Only the foreman on the floor, the maintenance man, and the electrician have access to the hand disconnects and starters, since only these three men have keys to the cabinet doors. When an overloaded motor causes a relay



Each machine has its own 110-volt control circuit and telltale lamps to indicate whether it is operating



Control panels carry a group of starters comprising magnetic switch, hand-operated disconnect switch, and fuses. The small transformer near the top steps the 440-volt line voltage down to 110 volts for the control circuits of the starters

to trip, the relay can be reset only by one of these men. Thus a careful inspection of the machine, the motor, and the circuit is more likely to be made before attempting to restart the motor than if some unauthorized person were able to reset the relay.

The same control is exercised over the renewing of fuses. Replacement by the ordinary workman is prevented, since this operation is more dangerous than many suspect. Overfusing should never be allowed. Operators are sometimes tempted to overfuse heavily loaded circuits.

The panel system of assembling motor starters thus permits the ready adoption of reliable and convenient means of insuring safety to workmen and equipment. Grouping of starters as we have done places the responsibility for proper maintenance upon those to whom such responsibility rightfully belongs—those who are best trained for keeping the lines in operation.

All motors are rated at 440 volts, but for the sake of safety to workmen it is necessary to step this voltage down to 110 for all control circuits of which the push-buttons are a part.

Where individual starters, without grouping in panels, are used with low-voltage control circuits a step-down control circuit transformer must be installed with each starter. With the present layout the investment in transformers is greatly reduced, and space is saved by taking advantage of the compactness of the installation, which makes it possible to use only one transformer for each panel. This transformer is located near the center of the panel and supplies 110 volts for the control circuit of each starter in that panel.

The new layout adds greatly to the general appearance of the department. Instead of starters of many kinds, shapes, and sizes scattered over the plant, and a maze of conduits running along machine frames, up posts, and along the ceiling, a greater sense of orderliness pervades the place.

Simplified maintenance, standardization of controls, greater safety, and better appearance have been made possible. These advantages show the need for giving thorough consideration to the location and nature of motor control equipment in the rehabilitation of plants.

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What of Works Councils?

IN ANY plant large enough to make it impossible for the manager to meet and greet each employee personally at least once each week, a works council is highly desirable.

Trade unions at best are founded on generalities and are not completely adapted to the conditions and needs of an individual plant, whereas a works council, being born and raised within the factory in which it is to operate, must of necessity fill the needs of that plant.

A works council properly organized and conducted will invariably result in the following benefits:

1. The employees become interested in their company, its products, and their own work. (First through curiosity about the plan; then through interest in the plan and the company; finally through understanding.)

2. The workers, knowing that they have a part in controlling their own working conditions and that, through representatives, they may air any real or fancied grievance with the management, lose the attitude (almost universal with the general rank and file of shop employees) that the management is "high-hat" and will not talk or listen to them.

3. It removes the possibility of a small wrong remaining planted as a germ where it will fester and spread until it suddenly breaks forth in the form of serious labor trouble before a surprised and entirely unprepared management.

4. It provides a means for management to portray its side of a problem in a convincing manner.

Works councils and trade unions will not operate successfully in the same plant simultaneously unless the trade union fulfills all the needs and conditions of that particular plant and community, and in that case the union is performing the same functions as the works council and is therefore unnecessary, although it may be retained if desired.

To be effective, a works council must consider all phases of plant control, costs, and working conditions. To endeavor to operate a works council without discussing wages and hours is comparable with attempting to operate an automobile without a storage battery. Once the car is running and the generator is supplying enough current to fire the motor, the car will continue to operate until conditions change, whereupon it stops never to start again until supplied with a new battery.

G. B. GREENWOOD
Industrial Engineer, Piermont Division
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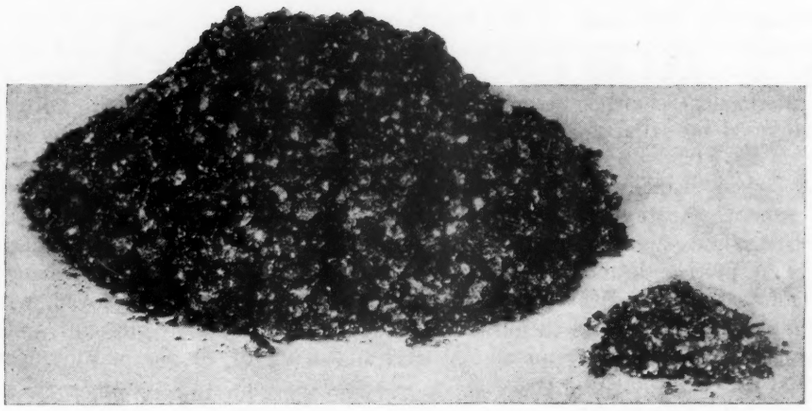

What more effective demonstration of the high cost of poor lubrication than these piles of cuttings screened from oil in the housing of a 24-in. merchant mill?

Lubrication *Can* Avoid Friction's Toll

Reginald Trautschold

Consulting Engineer
Pompton Plains, N. J.

THE CUTTING of mechanical costs in industry—more economical and effective utilization of the basic media of heat, light and power; reducton of mechanical wastes—is an outstanding problem of the New Deal. Only by effecting economies in mechanical operations can the NRA program succeed. Only by so doing are higher wages, steadier employment, and a permanent shorter working week made possible.

Among the more common of the mechanical wastes is the heavy toll claimed by friction—in journals, crossheads, stuffing-boxes, between meshing gear teeth—in fact, wherever there is resistance to directed movement. The damage done by friction is one of the chief causes of high production costs, responsible in large part for many of the usual interruptions to productive activities.

Lubrication is the customary antidote for these friction ills, but it is one with which many industrial plants are still strangely unfamiliar. True, the basic requirements for a suitable lubricant are pretty generally known, and great quantities of oils and greases are used each year. Nevertheless, many millions of dollars are squandered annually in paying tolls on friction burdens that are in large part preventable.

Some striking indication of the destruction caused by friction and a convenient measure by which the occurrence of frictional wear can be readily determined, are needed before industry at large learns to appreciate the high price it pays for inadequate attention to its lubrication needs. Worn bearings, scored stuffing-box rods, gear teeth failing through profile destruction, and similar results of continued frictional wear are visible, but apparently not striking enough, indications of the appalling friction dole. They usually appear gradually, and the damage has progressed far, as a rule, before it is noted and measures are taken to relieve the situation.

In journal friction, it is not easy to visualize the progress of wear because the metal removed is carried away by, or dissipated in, the ineffective lubricant employed. However, in other instances concrete evidence of both the results and amount of cuttings or scrapings removed by friction can be seen.

The piles of metal scrapings illustrated, part of the cuttings screened out of the oil in the housing of a 24-inch merchant mill in a steel plant, leave little to the imagination. The gears of the mill operated in a bath of lubricant especially recommended for the severe service, yet within a few months the gear teeth showed marked evidences of cutting and pitting. A heavier bodied oil was then substituted, but this did not stop the destruction. In fact, after the delicate profile of the gear teeth had been destroyed, conditions appeared to become worse. At this stage, an investigation was made by lubrication experts, and by using a more suitable lubricant the life of the mill gears was trebled.

An even more outstanding improvement was made in another steel mill, with much larger gears involved—an improvement that is especially noteworthy because the gear unit had been in service for fifteen or sixteen years prior to the time the lubrication problem was given suitable attention. During all this time, the life of the ex-

pensive gears averaged about eleven months each and sixteen or seventeen replacements had been necessary. Simply by substituting what proved to be a much more suitable lubricant, but making no mechanical changes whatever in the unit, the gears have stood up satisfactorily for from two to three years.

While the foregoing instances may appear to many as too outstanding to be typical, the general situation is really of much the same order. The pulp and paper industry, for example, is a large user of lubricants and probably has given the question of lubrication as much attention as most industries. Despite this, the cost of lubricants per ton of finished paper runs in different mills from 5 to 50 cents and even higher on similar products. This is a considerable range, one that influences in no small measure not only the price of paper, but profits or lack of profits as well.

A paper mill with an output of 100,000 tons per year may expend $60,000 and upward annually for oils and greases, while another mill with about the same output may not have to spend more than $4,000 or $5,000. These figures, moreover, cover only the cost of lubricants and take no account of the much heavier burdens imposed by failures and damage attributed to faulty lubrication.

Some Specific Savings—What has been accomplished in some instances can be done as successfully in others. Hence the attainments in a few progressive paper mills (Table I) are of interest.

TABLE I. Lubrication Savings in Four Paper Mills

1. **Lubrication costs reduced from 16.3 to 7.7 per cent per ton of paper.**
2. **Maintenance and lubrication costs reduced $1,200 per year.**
3. **Saving of 50 per cent in oil consumption.**
4. **Mill operating expenses reduced $100 per month.**

In one mill where cost of lubrication on two paper machines had been averaging 16.3 cents per ton, a lubrication engineer recommended that the oil boxes on certain sections of the machines be revamped, a circulating oiling system installed for the drier sections, and the lubricants applied according to a procedure he advocated. This was done, with the result that lubrication costs per ton promptly dropped to 7.7 cents. On a daily output of 500 tons, this means a net annual reduction of close to $15,000 in operating expenses.

In another paper mill, considerable difficulty had been experienced in the lubrication of friction blocks on five rewinders. Consultation brought the startling recommendation that water be employed as a lubricant in place of grease. The result has been that maintenance and lubrication expenses have been decreased an average of $100 a month.

Savings were realized in another mill, in contrast, by using a more expensive lubricant. This was in the bearings on super-calenders where difficulties had been experienced when depending upon a brand of oil costing 40 cents a gallon. A brand that cost 46 cents was substituted, and not only were the former difficulties overcome, but the more expensive oil stood up so much better than the other that oil consumption was reduced by 50 per cent while lubrication costs were cut 42.5 per cent.

At a fourth mill, the lubrication of a twin piston valve, 1,500-hp. engine, operating at 125 r.p.m. and driving a direct-connected electric generator, had been giving trouble. The engine was not equipped with tailrod supports for the heavy pistons, and the lubrication supplied did not suffice for protection against cylinder wall scoring. A shutdown resulted for reboring the damaged cylinders, piston ring replacement and repacking, entailing a considerable cash outlay as well as costly interruption to mill activity. Following this overhauling, a change was made in the variety of cylinder oil employed, with the result that the engine ran much more efficiently, effecting an annual over-all saving of $1,200 in mill operating costs.

TABLE II. Reduction in Lubrication Expenses per Ton Output in a Canadian Newsprint Mill

	Before	*After*
Power, pulp, and stock departments	$0.06	$0.04
Machine rooms	.23	.11
Salary of lubrication supervisor		.017
Total for mill	0.29	0.167
Net annual saving		$11,900

A few years ago, to cite still another example (Table II), a Canadian newsprint mill, making both pulp and paper, discovered that its total lubrication cost ran 29 cents per ton of finished output. Its machinery and equipment were modern and well supplied with automatic lubricating devices, so this charge was felt to be higher than necessary. A lubrication expert was called and the suitability of the various grades of lubricants employed carefully investigated, one of the mill employees being assigned to the task of supervising lubrication.

By following the recommendations made, including some slight changes in methods of application, the lubrication cost for power, pulp production, and stock preparation per ton of finished paper was reduced 33⅓ per cent. In the machine rooms, the saving was 50 per cent, and the cost of lubrication for the entire mill per ton of finished product was cut from 29 to 16⅔ cents—a net reduction in operating costs of close to $12,000 annually and a steady job for a lubrication supervisor.

From these few isolated, but quite typical, examples of what has been accomplished in the way of cutting production costs by improvements in lubrication practices, it is evident that there is still much to be done by industrial plants along these lines, that great opportunities abound. Advance of this character is one of the aims of the NRA. It will help in business rehabilitation and growth. It ranks high in possibilities, and the industrial plant that neglects to investigate the tolls it now pays out to friction is simply not doing its part.

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What place has the credit union in a company's industrial relations program? For that matter, what *is* a credit union? A March article will bring you up to date on this interesting tool of management

Gas Correction Factor
What It Is——————How Applied

R. H. Parrish
Mission, Tex.

MANY engineers do not fully understand what is meant by the correction factor or multiplier that is commonly used in computing the monthly gas bills of industrial plants. Fewer know how it is derived or how it may be checked.

I recently talked to the general manager of one of the largest industrial concerns in the Southwest who had paid gas bills computed by the use of a correction factor and averaging $400 a month for the past ten years. Although the correction factor increased the amount of each bill considerably, this executive did not know what it meant. Some subordinate had satisfied him by informing him that it was because the gas supplied was richer than was stipulated in the contract. As a matter of fact the gas-burning equipment in the establishment, because of its design, operated most efficiently on a gas pressure slightly higher than the standard 8-oz. pressure on which the gas rate was based. For this reason the gas company had been requested to boost the pressure at the meter and, in so doing, was entitled to an increased rate in proportion to the increased pressure. The charge for gas is based upon the actual heat units consumed. A gas meter built to measure 1 cu.ft. of gas at an 8-oz. pressure would still measure only 1 cu.ft. if gas were supplied at a pressure of 2 lb. per sq.in. at the meter, but owing to the increased pressure, more heat units would be crowded into that cubic foot.

The correction factor is therefore that factor by which the meter consumption must be multiplied to include the extra heat units consumed due to the increased pressure. It also can be defined as the ratio between the heat units per cubic foot at the pressure at which gas is supplied and the heat units per cubic foot at standard 8-oz. pressure. Because the number of heat units in 1 cu.ft. of gas is in direct proportion to the absolute pressure at the meter, with a slight correction for temperature to be discussed later, the correction factor can be expressed in terms of the ratio of absolute pressures.

For example, if the gas regulator is adjusted at the request of the customer to a point where gas at the meter is furnished at 2-lb. per sq.in. pressure instead of the standard 8-oz. pressure, then the amount of gas that the customer would be billed for would be the amount registered by the meter between billing periods multiplied by the correction factor. Assuming uniform temperatures, the quantity of gas supplied would be in proportion to the ratio of absolute pressures corresponding to 2 lb. per sq.in. and 8 oz. per sq.in. respectively. The absolute pressure depends upon the elevation and atmospheric conditions existing at the time at the specific location as indicated by the barometer reading. From this information we arrive at the formula:

$$\text{Correction factor} = \frac{\text{gage pressure} + (0.49 \times \text{barometer reading})}{\left(\frac{\text{standard pressure in oz.}}{16}\right) + (0.49 \times \text{barometer reading})}$$

Substituting a 2-lb. per sq.in. gage pressure at the meter, an 8-oz. standard pressure, and a 30-in. barometer reading, the above equation becomes

$$= \frac{2 + (0.49 \times 30)}{\left(\frac{8}{16}\right) + (0.49 \times 30)} = 1.09$$

If during the month this customer used 1,500,000 cu.ft. of gas, he should be billed for 1,500,000×1.09, or 1,635,000 cu.ft. of gas.

Generally the standard temperature on which the gas rate is based is 60 deg. F. If an average of 80 deg. F. prevailed, the correction factor would then become:

$$\frac{[\text{gage pressure} + (0.49 \times \text{barometer})] \times (60 + 460)}{\{(8/16) + (0.49 \times \text{barometer})\} \times (80 + 460)}$$

$$= \frac{(2 + 14.7) \times 520}{(0.5 + 14.7) \times 540} = 1.05$$

And the customer would be billed for 1,500,000×1.05 or 1,575,000 cu.ft. of gas.

Changes of temperature seldom are taken into consideration for the reason that, the gas line being underground, the gas temperature does not change as readily as does the air temperature. Also, temperature varies with the seasons, which fluctuation would entail a tremendous amount of additional labor in figuring the monthly gas bills. The factor arrived at by not taking temperature into account will apply during all seasons and to all customers being supplied gas at the same gage and barometric pressures.

It might be assumed from the preceding paragraphs that, if the gas company were to raise your gas supply pressure without your knowledge and continue to bill you at standard-pressure rates, you would be the gainer. This assumption, however, would not necessarily be true because, unless the amount of air added at the burner adjustment is also increased accordingly, few if any additional heat units would be secured from the flame. Moreover, you would actually consume more cubic feet of gas with the same burner opening. It must be remembered that for efficient combustion there must be a proper proportion of gas and air.

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

FEBRUARY, 1934

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Hours and Wages

STILL a tremendous issue at NRA is the question of hours of work in American industry. General Johnson recently said he felt that "eventually this whole country has got to go to a shorter work week," and he was talking in connection with his grant of a 40-hour week to replace a 35-hour week to the automobile industry. He felt that any reduction of hours would have to be in units of eight hours for the benefit of the continuous process industries which, as he put it, include "most of the big employing industries."

Asked if he meant 32 hours instead of the traditional 30, he declined to say, but he did point out the difficulties of immediate adoption of a shorter work week, saying that "there are a lot of these companies which have exhausted their working capital and their reserves and can't borrow money; you have to consider that condition of industry or you will get kickbacks —bankruptcies and all that sort of thing—that will practically nullify all of your efforts." He added that it was "not a simple question," but gave a glimpse of the realistic attitude that animates NRA in many of the major issues before it.

The issue of varying scales of wages for the differently skilled types of labor within each industry persists. NRA attorneys have firmly stated that this is not the intent of the law, which specifically provides that minimum wages only shall be fixed in the codes, but labor is not through. The construction code was long held up by the President pending a settlement of that contention, for union labor took the issue direct to the White House after it had been overruled in NRA.

There is no doubt that if the NIRA is reopened for amendment at the present Congress, one of the surest things about those amendments will be one with provision for wage scales in the codes, unless labor organizers give heed to the cynical observation of more than one observer that if such provision is written into the codes the need for labor unions might seem much less, to the workers, than it does now.

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Passing Dead Center

EVERY such economic convulsion as that from which we now emerge brings great changes in its wake. New wants and new ideals replace the old, new industries emerge, old landmarks disappear.

For many factories the period of forced inaction has been one of quiet, carefully guarded renovation. New products are on the drafting board and in the experimental laboratories. Equipment has been overhauled and relocated, and many an otherwise idle organization has been hard at work modernizing tools and fixtures and often pushing on to revolutionary innovations in method. These companies are not waiting for change, they are making it. For them change spells, not fate, but opportunity.

The normal human rebound from despondency puts at the service of today's industrial leader a force that should go far in tomorrow's creative accomplishment. However, it is a force that needs effective outlet—an outlet that can be provided by immediately giving movement to plans, providing for them a dynamic status in the interest of rebuilding confidence and belief.

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What Cost Maintenance?

ASKING "How much should be spent for maintenance?" is about like asking "How old is Ann?" Neither question can be answered until and unless other facts are known. For both problems we find that there are other facts.

Forgetting Ann, and going on with maintenance. How much should be spent for maintenance in proportion to what is spent for production? is a question that begins to take on a semblance of rationalism. However, still further data are required. What is the product? What does the questioner mean by maintenance? What is the equipment policy of his company as to obsolescence? And still others.

Attempts have been made to determine yardsticks for measuring maintenance. One plant engineer has devised a system of establishing the one best ratio between productive and nonproductive costs. Other engineers have constructed graphs showing how the ratio of maintenance employees to total employees varies in different industries.

These yardsticks are elastic, which is something that a yardstick shouldn't be. But, flexible as they are, they constitute valuable guides. Certain maintenance engineers have used them for the approximate, or trial, over-all measurements against which they have constructed definite measuring devices applicable to their own products in their own plants.

From their experiences (some already published in *Factory,* others on the way) it is easy to conclude: That there are fundamental principles upon which any maintenance policy can be based. That the maintenance function must be definitely bounded (by definition in detail) for the specific plant concerned. That the same kind of orderly procedure as to orders and records that is used in controlling production must be used in controlling maintenance. That the plant man responsible for worthwhile maintenance will have proper executive standing. That the function needs at its head an individual of both engineering and managerial ability, big enough to organize and direct a procedure that will not necessarily be just like the procedure used in any other plant.

•

Barleycorn

OLDER personnel managers will not have forgotten blue Monday with its greater absenteeism, higher accident rate, attributed to John Barleycorn, king of Saturday nights.

There are those who say that prohibition took away the low-priced hard drink that once made the big Saturday nights; predict that with repeal we may expect a recurrence of Monday annoyances and disasters.

The situation is one to watch. If it turns out that Monday gives trouble, there is a job to be done. Having proved that forced abstinence will not work, we may decide that there is something in the right kind of educational process. Perhaps the best thing to do is to turn the job over to the safety departments, which have a habit of getting good results.

A Voice for the Engineer

THE RECENT resignation of L. W. Wallace as executive secretary of American Engineering Council, after thirteen years' service, calls attention to that organization.

American Engineering Council is the outgrowth of a movement inaugurated thirteen years ago by the Federated American Engineering Societies to establish at Washington a medium for engineering-economic research and expression of engineering thought and opinion in questions involving engineers and engineering in our public life.

The organization has done much good work, beneficial to engineers as individuals, to engineering as a profession, and to the government —which is to say the country. Unfortunately, the resultful work of the Council has been accompanied by the engineer's usual lack of appreciation of the need for making accomplishment known.

During its thirteen years of existence the organization has been guided by earnest officers and a strong secretary. Luckily, the men now taking office are of the same caliber. John F. Coleman, consulting engineer of New Orleans, and past president of the American Society of Civil Engineers, is the new president. Frederick M. Feiker, formerly director of the Bureau of Foreign and Domestic Commerce, is the new executive secretary.

With the accelerated direct interest between government and industry, it is desirable that engineers have an organization through which they can make themselves heard and felt as a whole. Behind all industry there is engineering; especially in the important capital goods industries is engineering the foundation.

A hundred thousand engineers undoubtedly have among them much knowledge and many opinions of value to the welfare of the nation. Through American Engineering Council, by means of their local and national societies, they have access to the nation. Certainly they should make frequent use of it.

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Index Available

UPON request a copy of the index of the editorial contents of FACTORY MANAGEMENT AND MAINTENANCE for 1933 will be sent free to any subscriber. Write promptly, please, addressing the editor.

SHORTS FOR MANAGEMENT FOR MAINTENANCE

Screen Guard Permits Narrower Aisles

FRANK ELLWOOD, Fairbury, Ill.

In consolidating a department of women workers operating bench-type coil winding machines, it became necessary to reduce the width of the aisles about 6 inches. The difficulty lay in the hazard to forewomen and inspectors, and to operators when they left their positions at the machines, thus exposing their skirts to the lineshafts, belts, and pulleys mounted beneath the front edge of the long work bench where they would be out of the way of the operators.

This hazard was removed by erecting a wire screen extending from the bench about halfway to the floor but well below the lineshaft and pulleys. The screen is mounted in sections and hinged to the bench to permit easy access for adjustment to belts, lubrication, or maintenance. As the screen does not reach the floor, it does not interfere with sweeping and cleaning. The women pass freely up and down the aisle thoroughly protected from the lineshaft.

•

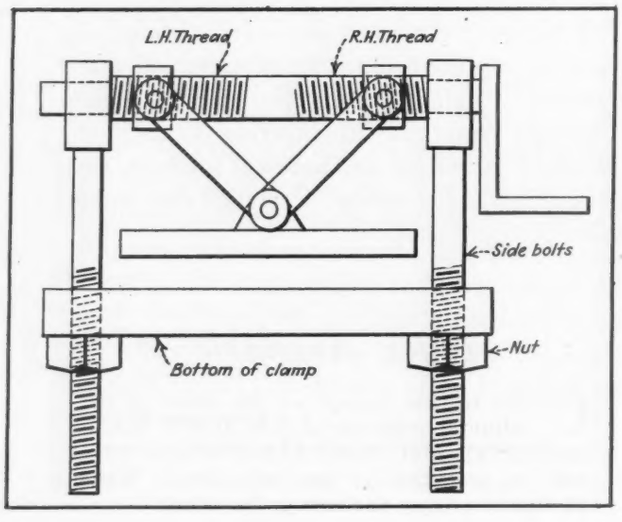
Screw Toggle Clamp

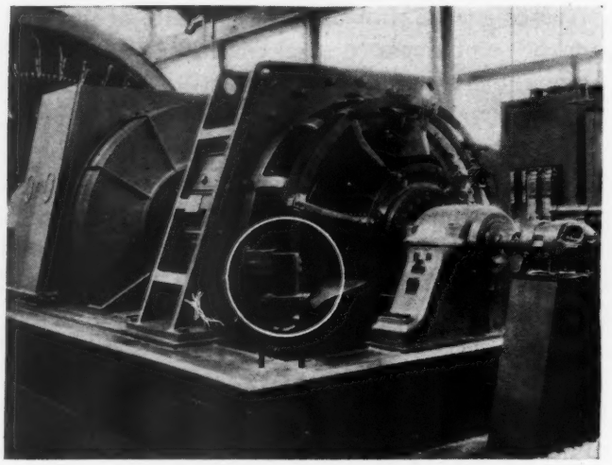
R. M. THOMAS, Denver, Colo.

Here is an equalizing clamp especially useful in the pattern shop and foundry. It can be tightened quickly.

The main toggle joint nut screw has right- and left-hand threads. By turning the crank the operator is able to exert pressure against material which is placed on top of the bottom clamp plate and hold it parallel with the toggle joint clamp plate.

The clamp can be adjusted to any desired height by running the bottom clamp adjusting nuts up or down.





This motor-generator set is photocell-protected. Before a flashover on the commutator has had time to do any dirty work, a relay opens the circuit breaker

•

Fusing Open-Delta Transformer Banks

C. O. VON DANNENBERG, Brooklyn, N. Y.

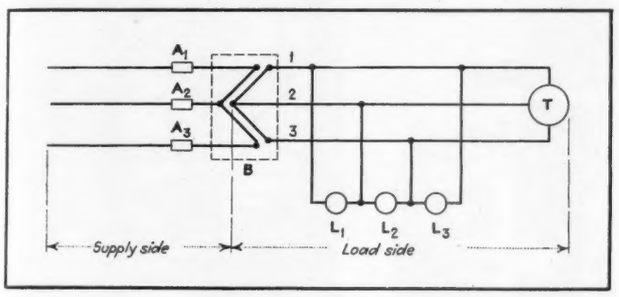
Necessity for reducing to a minimum energy consumption and losses during periods of low production is apparent, whether energy is purchased or generated. Where transformers are used for three-phase distribution one transformer in a bank of three single-phase units or even one element of a three-phase unit may be eliminated if the connections on the high- and low-voltage sides are delta-delta.

This procedure brings up the question of proper fusing. The diagram indicates an open-delta bank B fed through fuses A_1, A_2, A_3, and connected on the low-voltage side to a mixed load consisting of three single-phase loads L_1, L_2, L_3 and a three-phase load T. Assume that fuses A_1, A_2, and A_3 are of the same ampere capacity and that fuse A_2 blows. Then single-phase loads L_1 and L_2 will receive only one-half voltage, and three-phase load T will operate single-phase. If loads L_1 and L_2 are single-phase motors they will probably stop, if loaded somewhere near to capacity. If thrown on the line they probably will not start and in case control were automatic and operation not observed, would burn out. Whether three-phase motor T would operate single-phase, would depend upon the load. There is the possibility of its overheating or burning out if it is loaded to capacity on three-phase operation. The greatest danger, of course is with the single-phase loads.

It has been the custom to recommend fusing line *2* to a higher ampere value than lines *1* or *3*, or to allow fuses A_1 or A_3 to blow instead of fuse A_2. One large utility system has recommended fusing line *2* to a capacity varying from 150 to 200 per cent of lines *1* and *3*.

Whether such a practice is justified by actual experience is a much-debated question. One large system investigated the matter carefully and could not learn from its operating experience that there was definite indication of fuse A_2 blowing any oftener than A_1 or A_3. Hence, its instructions call for fusing all lines the same.

In spite of the possible operating advantage in fusing A_2 to a higher value there is always the chance that lines A_1 or A_3 may be fused, through error, to the same capacity as A_2. In this event the whole bank might be



endangered. Certainly the merits and disadvantages of both methods of fusing should be considered carefully before a decision is made.

No mention has been made of the unbalancing in the open-delta bank due to the system itself. This will not be a serious problem if load balancing is properly handled.

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On rainy days the doorman at a Pittsburgh plant greets visitors with an umbrella, escorts them from taxicab to main office building.

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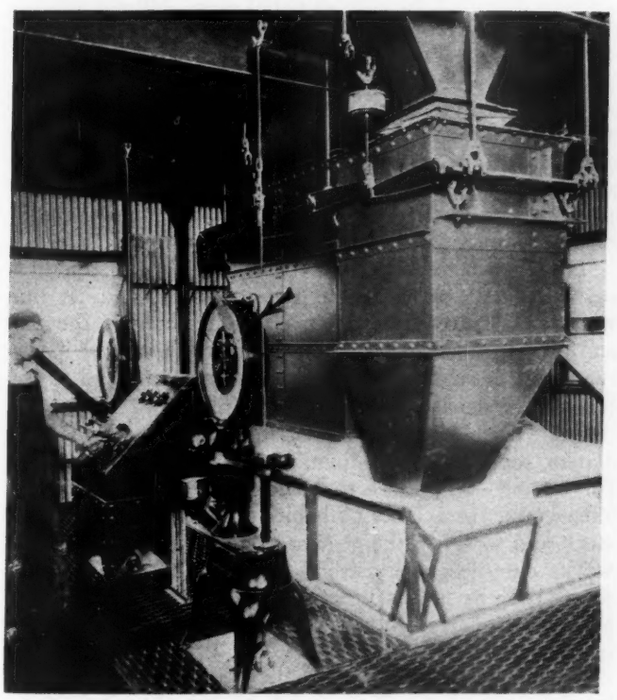
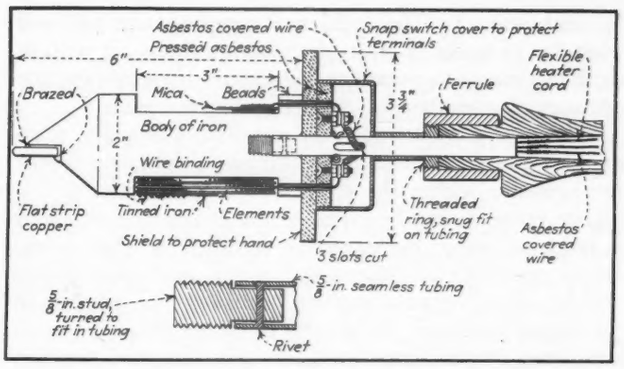


Brooklyn's batches must be right. The photocell sees to it in the Cranford Company's "ready-mix" concrete plant, where ingredients are automatically weighed and delivered to the mixer



Three-Heat Soldering Iron Handles Wide Range of Work

J. H. Sauve, Temiscaming, P.Q., Canada

A three-heat soldering iron that was made in our shop has been found to be very efficient and handy. The sketch shows the construction. Each of the three elements consists of 36 ft. of No. 19 B. & S. gage Chromel A wire.

It will be seen that the tip differs from the conventional type. I do not like screwed or inserted tips because scale always forms at the joint and hinders the transfer of heat. The tip we use is cut away as shown and a strip of flat copper about $\frac{3}{16}$ in. thick and as wide as the tip is brazed to it at the front and back. The copper strip extends about 1 in. beyond the tip. When the strip wears away it is a simple matter to cut through the brazing and put on a new tip.

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Don't Guess About Gas

C. C. Hermann, Waterloo, Iowa

A flow of gas in a pipe line depends upon the quantity of gas required and the pressure drop in the line. Usually where trouble develops in the gas distribution system it has been found that these points have been either guessed at or entirely ignored.

With regard to quantity required there is little or no excuse for a guess. The mere addition of the consuming units in cubic feet of gas per hour should give the answer, and that information can be obtained from manufacturers.

As to pressure drop, the line must be designed so that the drop from the initial to the final pressure will not be great enough to reduce the normal or rated capacity of the gas-consuming unit. Equipment manufacturers usually state the gas-consuming capacity in terms based on a given terminal pressure. It is up to the designer to see that this pressure is obtained at the burner.

To reduce the line losses pipe sizes must be carefully figured. The cost of piping varies with the size of the pipe used, and often the size is cut to save a few dollars. Usually the saving is absorbed in just a few days of inefficient operation of the equipment, and then the installation piles up a loss until finally the entire installation must be overhauled.

What is the normal working gas pressure in most in-

dustrial plants? The local gas company can tell you what the pressure is on its distribution lines. It will, in most instances, cooperate to the extent of measuring the pressure at advantageous points within the plant.

Wherever possible industrial gas should be taken from the high-pressure mains and reduced to the lower working pressure within the plant. It is even better if the higher pressure can be piped to the consuming unit and a reducing valve or governor installed at that point. Better operating conditions will obtain, and some saving will be made because smaller pipes may be used with the higher pressure. In several instances excessive pressure drop in pipe lines has been overcome and troubles eliminated by changing from a low-pressure to a high-pressure distribution instead of tearing out and installing new and larger lines.

The flow of gas in a low-pressure line varies directly as the square root of the fifth power of the pipe diameter; directly as the square root of the pressure drop, and inversely as the square root of the specific gravity of the gas. The following formula gives very accurate results with low-pressure gas:

Q = gas flow in cubic feet per hour
d = diameter of pipe in inches
h = drop in pressure from one end of the line to the other in inches water column
l = length of line in feet
s = specific gravity of gas, air — 1.00

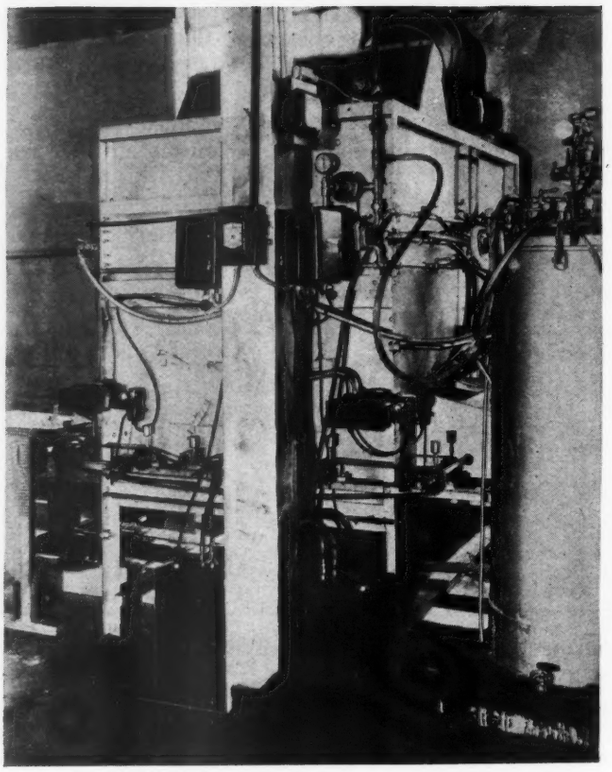
Then $Q = 1350\ d^2\ \frac{h\ d}{3\ s\ l}$

The pressure drop for a given pipe line for a furnace requiring, say, 300 cu.ft. of gas per hour and located, say, 100 ft. from the main should not exceed 0.5 inch water column. The size of pipe required for such service would be $1\frac{1}{4}$ in. where the initial pressure is 6 inches water column. Many instances have come to my attention where plant engineers try to draw as much gas through a 1-in. line. Obviously they encounter considerable trouble. A 1-in. line will deliver approximately 135 cu.ft. per hour.

When figuring gas lines it is necessary to start with the equipment and figure back to the main. Since the gas consumption of the appliance is known, the size of pipe required to sustain the flow of the given volume with a reasonable pressure drop can be selected from a table of pipe sizes or figured by use of the formula given above. The flow must be calculated from the appliance to the junction with the line. Each branch must be handled as a separate problem, the combined carrying capacity of the mains figured, a drop in pressure assigned, and sizes determined.

The pressure drop should not exceed 0.5 inch water column in complete runs of piping. The mains should be designed with a pressure drop not to exceed 0.3 inch water column and less for the reason that some room for expansion should be provided. It is more economical to provide a larger main than immediately needed to take care of expansion within reason. Local considerations, of course, must govern.

Considerable trouble in gas systems has been traced to meters. Where meters are installed for cost accounting purposes on a given appliance, be doubly sure that they are ample in size.



Lumber is spray-painted as it passes through this machine. It would be wasteful to have the paint sprays going all the time, so photocells turn them on only when a piece of lumber is in the machine

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To Cut One-Piece Lot Costs

Small lots in a mass-production plant are always expensive, and frequently they involve a great deal of waste—as was known at Stewart-Warner Corporation, Chicago. One of the items frequently called for here is a sample, for instance a slightly different oil gage, with the dial reversed from standard. Some of these items are chargeable to the customer; others are logically development expense. But the actual cost and the preliminary estimate, or price given the customer, usually varied greatly, with a considerable loss to the plant.

The former practice was to turn over the job to a highly skilled toolmaker in the toolroom, and let him work it out. Recently, in an effort to decrease the cost and also to make costs fall within prices, the plan was changed. Now the specifications or drawings go to the tool-design department for specific planning.

For example, it may be possible to use standard gear blanks, merely sending them to the hobbing department for cutting—whereas a toolmaker, given the same problem, would from force of habit start with a piece of bar stock and work up the gear at the bench. The estimator works out the exact method by which the job is to be done; then he makes up a detailed cost estimate by operations or parts. When he has finished, the job goes into the shop.

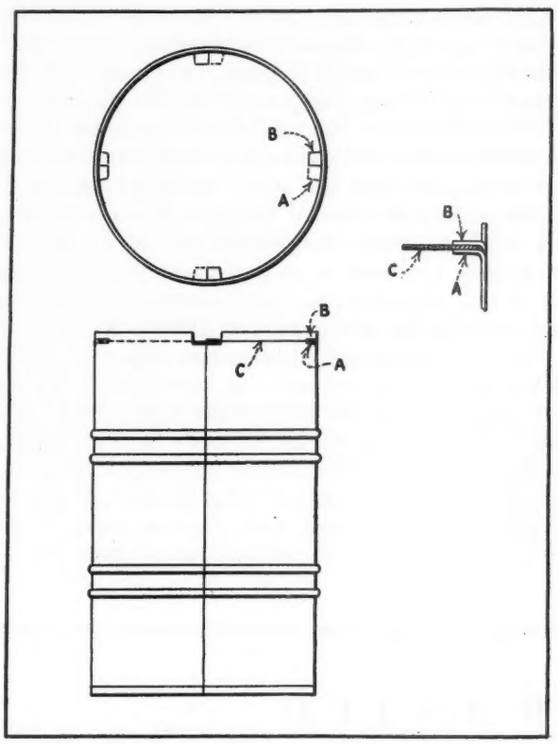
No longer do costs run wild. Now there is definitely known just what will be involved, whether it is a development or a customer's job. And while extras have not been entirely done away with, they are greatly reduced, and the total cost comes close to the estimate.

Use the Old Head

JAMES J. BAULE, Boston, Mass.

When sheet-steel drums that have been used for containing alcohol, oil, or grease are converted into containers for shipping solid materials, such as non-ferrous scrap and various by-products, the cut-out disks (the old heads) may be used.

Cut out the disks as close to the vertical walls as possible. This may be done well and rapidly by means of a



cold chisel, without undue distortion of the disk. Then cut four or six pairs of strips, *A* and *B*, each 1½ in. wide and between 1 and 1½ in. from the top vertically down the sides of the drums. Next, bend in one strip *A* of each pair (as illustrated in the detail) for the cover *C* to rest on. Then put the cover over these strips and bend the remaining strips *B* over the cover to hold it down.

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If you operate a fleet of trucks, look into the gas-saving gadget that shuts off the engine after three minutes of idling.

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Reduced Demand Means Lower Power Costs

N. T. PEF, Efficiency Engineer
Crerar Clinch Coal Company, Chicago

Considerable reduction in power costs can be effected by maintaining a high load factor or a high ratio between the maximum and average loads. Each installation presents its own problems but in general the method of solution consists of studying the period during which the peaks occur and stopping the operation of such equipment as can be dispensed with during this time. Some years ago I had supervision over a public building and was able to reduce the power bill almost $100 a month, which was not inconsiderable for a relatively small institution.

The peak period occurred during 11:30 a.m. and 12:30 p.m. because of increased use of the elevators. Along with other equipment, an ammonia compressor, a brine pump, and a storage water tank pump were operated. After careful study it was decided that these three machines could be shut down during the peak period without affecting the service. When this was done the saving mentioned above was realized.

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A Cleveland concern stores wire on skid platforms, found it could use narrower aisles, get more storage room by storing at a 45-deg. angle.

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Inspections

T. S. JARDINE, Plant Supt., United Drug Company
Toronto, Canada.

The great majority of breakdowns never happen, and plant equipment is always in sound condition when inspections are carefully and regularly made. The following routines are suggested:

WEEKLY—ON SET DAYS

Elevator headgear—car and gates
Automatic machine adjustments and lubrication.
Fire equipment, sprinkler systems, and fire doors.
Ladders, steps, trestles, etc.
Code system—key box and transmitter.

MONTHLY—DAY TO DAY

Motors and starters.
Ammeter load test on all motor loads.
Buzzers—annunciators, low-voltage circuits, and bells.
Shafting and hangers.
Counterweight ropes and cables on machines.
Refrigeration lines and valves.
Plumbing fixtures and fittings.
High-pressure steam lines, valves, and traps.
Low-pressure steam lines, valves and traps.
Water lines and valves.
Hydraulic pumps, accumulators, valves, and lines.
Air lines and valves—gages.
Gas lines, valves, and petcocks.
Vacuum lines and valves—gages.
Sprinkler lines and valves.
Outside property—sheds—fences.
Roofs and outside windows.
Inside doors and windows.

SEMI-ANNUAL

All pressure gages—test for accuracy.
Transfer pumps—check internal condition.
Process kettles and tanks—check linings and for leaks.
Recorders—clean clock movements if necessary.

ANNUAL OVERHAULS DURING SHUTDOWNS

Ice machine and condenser coils.
Reducing valves on heating system.
Reducing valves on process equipment.
Vacuum reducing valves.
Condensate and vacuum pumps.
Electric mains and feeders—insulation resistance test.
All large motors—wash and re-dope stator coils.

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Better Control of Lubrication

Some investigation of our methods of handling lubrication indicates room for improvement. Our equipment ranges from fairly heavy rolling mills and punchpresses to light machines operating at high speed. At least fifteen kinds or grades of oil are used, with about as many grades of grease. Each department keeps its own supply of lubricants, and operators are responsible for lubricating production machines. The maintenance department handles lubrication of all motors, of which there are about 400. We have a considerable amount of bearing trouble, which I believe could be lessened by better control. Use of fewer grades of oil and grease would also be desirable, if it is feasible. I wish that readers would suggest how we can handle lubrication to better advantage. How should we go about reducing the number of grades of lubricants used? J.M.S.—Cleveland

EXPERIENCE convinces me that lubrication should be controlled and supervised by the maintenance department. A number of excellent reasons support this contention, but the three which weigh heaviest with maintenance are regularity, inspection, and economy.

With the average run of machine operator production is the first consideration, and piecework rates often determine the amount of time spent on lubrication. I have known machines to be run continuously for 72 hours at a stretch, because the operators begrudged the time required to lubricate them, or left the job to the "other fellow," with dire results to the equipment.

Where there is a strict lubrication schedule enforced by efficient maintenance, bearings and other parts subject to unusual wear and strain can be adjusted and replaced at the first signs of failure. When lubrication is left to the operator the tendency is to let the faulty mechanism run until a costly repair job is necessary. All of this, of course, is directly antagonistic to a maintenance program which aims at cutting costs.

Finally, there is the all-important factor of economy in the time and money spent on lubrication. With control centralized in the maintenance department, a thorough lubrication survey can be made so that "standard" grades of oil and grease can be selected to cover all requirements. The statement that "at least fifteen kinds or grades of oil are used, with about as many grades of grease" would seem to indicate an obvious fact—that

ANSWERS WANTED

Replacing Elevator and Crane Cables

I should like to know how to determine positively when the wire cables used on elevators and cranes should be replaced. We want to use these as long as it is safe to do so, but do not want to take any chances of failure by keeping them in service too long. How often should such cables be inspected? What is their normal length of life? C.A.—Minneapolis, Minn.

Experienced Men as Motor Inspectors?

I feel that motor inspectors should be experienced men capable of diagnosing any kind of trouble with a.c. and d.c. motors and making any adjustments or repairs needed, short of complete rewinding. In another plant with which I am acquainted the policy is to employ inspectors who know very little about motors. They are instructed to report immediately any motor that does not seem to be running properly, judging by its sound, temperature, or other indications. An experienced repair man is then sent to examine the motor and decide what should be done with it. I have been told that the reason for this policy is that inspectors of considerable experience are too much inclined to use their own judgment as to whether and when a motor needs repairing. Any mistakes in judgment may result in a serious delay or breakdown. What is the opinion of readers on these two viewpoints? V.B.S.—Baltimore, Md.

How Explain This Winding?

A Valley type 52SP, three-phase, 1200-r.p.m., 3-hp. motor that was stripped recently had a 24-slot stator wound with pyramidal-type coils as follows:

Top and Bottom Layers	
Coil Throw	Turns per Coil
1-3	16
1-5	11
Middle Layer	
1-3	11
1-5	5

The coils were wound with No. 14 single-cotton, enameled wire and the winding was connected series star.

I wish that readers would explain why the middle phase has fewer turns, since it would seem that this arrangement would cause current unbalance with attendant heating and magnetic field distortion.

L.W.—Cape Girardeau, Mo.

departmental handling of lubrication is an expensive method that should be discontinued.

In order to reduce the number of grades of lubricant I advise J.M.S. to get in touch with a reputable company that handles good oils and greases. Any oil company will cooperate in making the lubrication survey I have mentioned, and undoubtedly can make suggestions that will eliminate "overlapping" and thus reduce considerably the number of grades now used.

As to handling methods, I advise the storing of all lubricants in a locked room where the temperature can be controlled. No lubricants should be stored or kept in the departments, thus eliminating a fire hazard and inducing economy in usage. Oils and greases necessary for the daily schedule can readily be transported to the various departments on a hand truck, and will be constantly under the supervision of the maintenance man assigned to the task.

ROBERT S. ALEXANDER
Special Department
Universal Winding Company, Auburn, R. I.

How Stop the Sparking of These Motor-Generator Sets?

We have three motor-generator sets, each consisting of a 4,400-kw. synchronous motor driving two 1,725-kw., 575-volt d.c. generators. These generators have always given trouble from excessive sparking at the commutators. The commutators have been ground and undercut, but nothing that we have done seems to make much improvement. These machines operate continuously, but are taken out of service once a month for such maintenance as is needed. I shall appreciate it if readers who have had similar trouble will tell me what to do.
A.P.—Flin Flon, Man., Canada

IF THE generators have always sparked excessively the attention of the manufacturer should have been drawn to this trouble.

Assuming that the generators are of the commutating-pole type, these poles may be either too strong or too weak. This condition would cause sparking under different loads. The manufacturer can give instructions on how to test for his fault, which is not easy to correct after installation.

If the generators do not have commutating poles it is just possible that the brush setting is not correct. In that event, tests under load must be made and the brushes shifted to give the best average setting for all conditions.

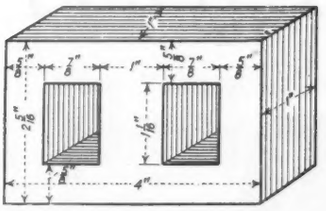
On modern generators of the commutating-pole type the brush rigging usually is not adjustable, but if it can be adjusted the first step would be to make certain that the neutral point is correct. Although it does not seem reasonable to assume that this condition might exist in all three units, it should at least be checked.

In the past considerable trouble was experienced because commutators were not well seasoned by thorough baking and tightening. Although this cause of trouble generally has been remedied it occurs occasionally.

The quality of the carbon brushes must also be considered; that is, whether they are too hard, or too soft, or of too high or too low conductivity, and so on.

C. O. VON DANNENBERG, *Brooklyn, N. Y.*

Winding Data for Transformer



What size of wire and how many turns should be used in the primary and secondary of the transformer core shown in the sketch? The primary will be operated at 110 volts, 60 cycles. I want to obtain 4, 5, 6, 7, 8, 9, 10, 11, and 12 volts from the secondary winding, which will have a load of 3 amperes.
D.A.M.—Youngstown, Ohio

THE 110-VOLT primary should be wound with 660 turns of No. 25 B & S gage s.c.e. wire. For the secondary use 72 turns of No. 15 s.c.e. wire tapped at:

24 turns for 4 volts
30 turns for 5 volts
36 turns for 6 volts
42 turns for 7 volts
48 turns for 8 volts
54 turns for 9 volts
60 turns for 10 volts
66 turns for 11 volts.

Care should be exercised in winding since there will be no room to spare. V. C. KIRBY, *Hutchinson, Kan.*

IN CONSIDERING this problem it has been assumed that the core material is an average grade of transformer silicon steel, that the coil will be wound on a mandrel, and that the laminations will be built around the coil. In this case, a $1\frac{1}{8}$x$1\frac{1}{8}$-in. mandrel should be used.

Core insulation should be three layers of $\frac{1}{64}$-in. fiber. Insulation between turns of both primary and secondary should be 0.002-in. kraft paper with a liberal application of a good insulating paint between each layer.

The primary should be wound with 635 turns of No. 25 enameled wire. Two layers of $\frac{1}{64}$-in. fiber should be used as insulation between the primary and secondary.

The secondary should be wound with 72 turns of No. 16 enameled wire, with taps as follows:

4-volt tap, 24 turns
5-volt tap, 30 turns
6-volt tap, 36 turns
7-volt tap, 42 turns
8-volt tap, 48 turns
9-volt tap, 54 turns
10-volt tap, 60 turns
11-volt tap, 66 turns
12-volt tap, 72 turns.

I have assumed the winding length to be $\frac{15}{16}$ in. and that the paper insulation between turns is 1 in. wide. On account of the limited winding space it will be necessary to get the maximum number of turns in each layer.

E. D. LITHGOW, *Milwaukee, Wis.*

(Continued on advertising page 38)

·EQUIPMENT NEWS·

Fire Alarm

Automatic. Called "Vitalarm." Fits ordinary electric light socket. Has small neon-type lamp, consuming about 4/10 watt, which glows constantly, marking location of unit and showing that it is operating. Device discovers fire and automatically sounds alarm. The Gamewell Co., Newton Upper Falls, Mass.

Fluid Valve

Electrically controlled. Type UB. Small d.c. coil operates valve and when de-energized allows valve to close. Sizes for use with pipe from $\frac{1}{8}$ to $\frac{3}{4}$ in. For each size there are coils for use on circuits of 45, 110, and 500 volts. Valves are suitable for controlling flow of compressed air, saturated steam, water, oil, and other gases and liquids. May be used on a.c. lines with addition of small rectifier. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Die-Heads

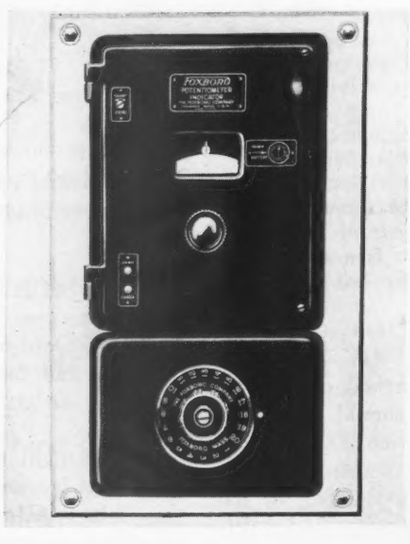
For use with Red-E-Haul portable power pipe threader. "Red-E-Quick" and "Double-Quick" heads employ two sets of dies for cutting all pipe sizes from $\frac{1}{2}$ in. to 2 in. With "Red-E-Quick" head, change of dies is necessary when shifting from $\frac{1}{2}$ or $\frac{3}{4}$-in. to 1, $1\frac{1}{4}$, $1\frac{1}{2}$, or 2-in. pipe. "Double-Quick" head has both sets of dies incorporated. Pipe is released automatically at end of cut. American Die & Tool Co., Reading, Pa.

Insect Exterminator

Electrically operated, for spraying insecticide. Operates on either a.c. or d.c. Current passing through electrodes heats liquid insecticide, generating steam pressure which causes hot vapor to issue and diffuse about room. Weight 6 lb. Size 6x4x10 in. The X-Termador Co., Springfield, Mass.

Pyrometer

Indicating Potentiometer. All adjustments located on front cover plate. Six-inch dial. Double-suspension galvanometer designed to withstand rough industrial use. Moisture-proof case for



surface or flush mounting. Selector switch enables use of indicator for temperature readings from any number of thermocouples located at scattered points. The Foxboro Co., Foxboro, Mass.

Slide Rule

"Tasco," circular, vest-pocket. Grease and water proof. Has black lines etched on nickel-silver plate. Weighs $3\frac{1}{2}$ ounces. Scales on disk $2\frac{3}{4}$ in. in diameter. Tavella Sales Co., 25 W. Broadway, New York.

Relay

Vacuum-contact, auxiliary-potential. Designated as Type HBA. For use in atmospheres containing explosive gases. Inclosed in steel container. Has single-pole, double-throw contacts in heavy-walled glass tube, one end of which contains metal bellows. Movable contact attached to bellows operates between two stationary contacts. Rated 15 amp. continuous, 10 amp. interrupting at 115 and 230 volts, 60 cycles, and 125 and 250 volts d.c. General Electric Co., Schenectady, N. Y.

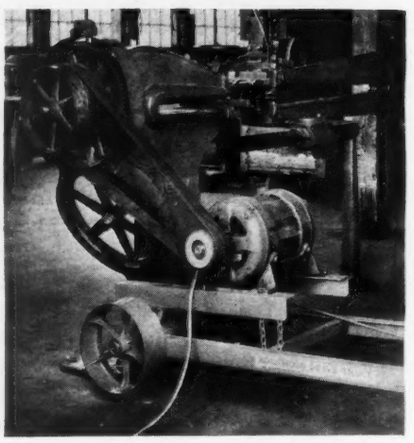
Paint

Called "Colored Masterseal." Water paint. Bituminous emulsion with colors as base. May be applied on damp or dry masonry surfaces, including fresh lime plaster, Keene's cement, green concrete, brick, stone, and tile—either by brush or spraying. Claimed to be unaffected by moisture after application, and not to discolor or rub off. May be washed. For both exterior and interior use. The Master Builders Co., 7016 Euclid Ave., Cleveland.

Drinking Cup Dispenser

Automatic. Called "Viking." Pull of lever at bottom delivers single cup. Cartons of 250 cups inserted entire. No hands need touch cups. Boston Drinking Cup Co., 315 Centre St., Jamaica Plain, Boston, Mass.

Power Drive Truck



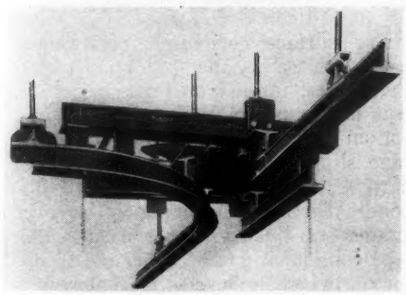
Portable. For driving machines temporarily in out-of-the-way locations, testing new machines, and replacing permanent drives where motor has had to be taken out for repairs. Accommodates motors from 2 to 10 hp., single phase or polyphase, also gas engines. Motor not furnished. Has Rockwood

pivoted motor drive base, stops for anchoring truck. The Rockwood Manufacturing Co., Indianapolis, Ind.

Turbine-Reducer

Type TFR steam turbine with built-in single- or double-reduction speed reducer. Can be supplied for either clockwise or counter-clockwise rotation. Herringbone gears. Coppus Engineering Corp., Worcester, Mass.

Switch



Sliding, monorail. Up to 3 tons capacity. Permits 30-in. spur-track spacing. Eliminates bending and fitting curves to switch, angular rail cuts. Has positive latching device. Curved and straight sections of T-rail are welded to sliding plate which moves to either position of switch on four rollers mounted on switch frame. The Osborn Mfg. Co., 5401 Hamilton Ave., Cleveland.

Car Door Opener

For opening and closing box-car doors. All-steel construction. Weighs 15 lb. Consists of $\frac{5}{16}$-in. copper-finished chain with hook and hand ring, cast-steel sheave and case. Case equipped with hook portion for attaching tool to handle of car door. Chain is drawn tight by hand ring and locked by weighted dog. Doors opened or closed by short pulls near center of stretched chain. The Mining Safety Device Co., Bowerston, Ohio.

Sandblast Machine

Known as Type "PB" Sly Pressure Blast Tank. For cleaning castings, forgings, heat-treated steel parts, structural steel parts, steel tanks, buildings, steel structures. Has removable screen over top and 1-in. blast hose in single lengths up to 50 ft. Effective capacity 3 cu.ft. of abrasive. Can be used with sand, metallic shot, or metallic grit. Operated by single control valve with but two positions. Furnished with welded-on legs or wheel mounting. The W. W. Sly Manufacturing Co., 4712 Train Ave., Cleveland.

Asbestos Products

Merger of Ambler Asbestos Shingle & Sheathing Co. with Keasbey & Mattison Co., both of Ambler, Pa., has been announced. Combined companies will retain name of Keasbey & Mattison. Products include magnesia and asbestos products, and asbestos-cement products.

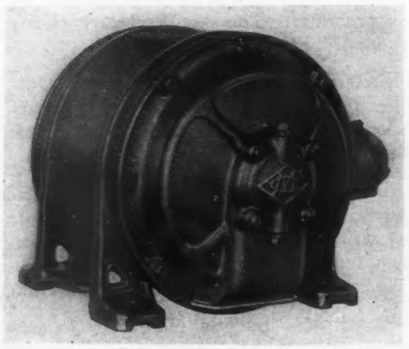
Panels

Self-supporting, steel, for mounting small oil circuit breakers in isolated installations. Suitable for use on ungrounded systems up to 2,500 volts. Breaker interrupting ratings are 20,000 to 50,000 kva. Shipped in full working order. Consists of isolated flanged steel panel with supporting feet welded on. Accessory apparatus can also be mounted on panel. Metal guard for back available. General Electric Co., Schenectady, N. Y.

Coil Winder

Universal, for making coils for motor armatures, fields, transformers, with diamond, round, square, or rectangular cores. Form tubes instantly removable from finished coils. Ideal Commutator Dresser Co., Sycamore, Ill.

Motors



Splash proof. Fully inclosed except for small openings on lower side of each end bell which are designed to prevent entry of splashing or falling water. Frame sizes same as for open-type motors of equal rating. Single-phase and polyphase squirrel-cage types up to 30 hp. Marble-Card Electric Co., Gladstone, Mich.

Compressors

Two-cylinder vertical, for ammonia and freon service. Capacities from 1 to 100 tons of refrigeration. Discharges oil regardless of rotational direction of compressor. Suction valve in top of piston. Discharge valve in removable safety head. Can be driven by direct connection, with synchronous motor, or through Worthington Multi-V-Drive to motor. Worthington Pump & Machinery Corp., Harrison, N. J.

Floor Resurfacing Material

For repairing and resurfacing worn or broken factory floors. Mixed with sand and cement, laid cold $\frac{1}{2}$ in. thick. Manufacturer claims that it will bond to concrete, wood, brick, wood block, asphalt, or composition floors, be ready for traffic 36 hr. after it is laid, is resilient, and will not dust. Called "Stonhard Resurfacer." Stonhard Co., 401 N. Broad St., Philadelphia, Pa.

Room Cooler

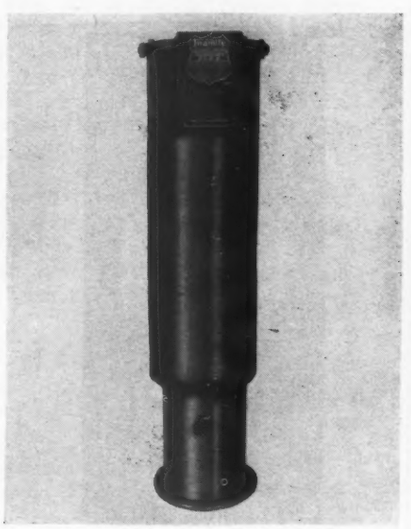
Self-contained, for offices. Cooling capacity of $\frac{1}{2}$ ton, equivalent to cooling effect of a half ton of ice melting in 24 hours. Both refrigerating and air conditioning equipment in one cabinet. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Storage Battery

Called "Electro-Pak." For trucks and tractors. Heavy plates, separators of vertical-grain Port Orford cedar with perforated rubber sheet insulators. Flexible lead-coated copper-strip connectors. Hard rubber or wood cases. The B. F. Goodrich Co., Akron, Ohio.

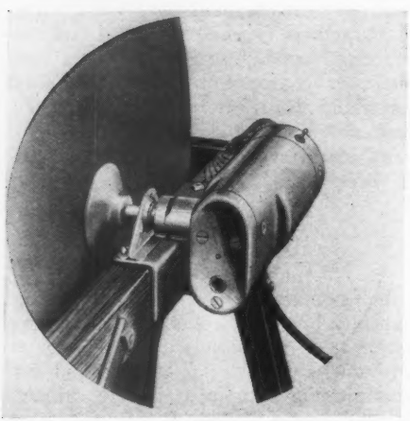
Fire Protection System

Foamite Type ST. For protecting dip tanks, drain boards, quenching tanks, mixing churns, cleaning tanks, and vessels containing flammable liquids. For stationary installation only. Moving parts totally inclosed. Actual inspection of interior can be made at



any time. Operates automatically on rate-of-rise-of-temperature principle or by manual control. Delivers durable bubbles filled with carbon dioxide for quenching flame. American-LaFrance and Foamite Corporation, Elmira, N. Y.

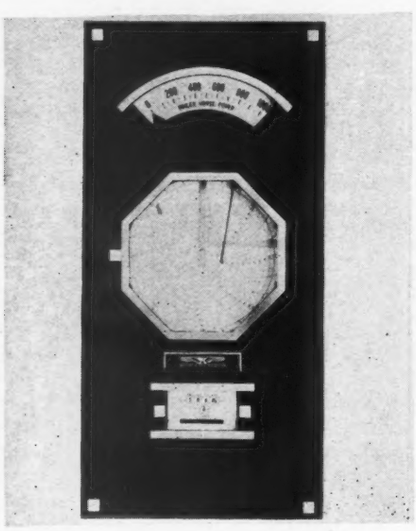
Grindstone



Motorized. Has small electric motor on one side connected through overriding clutch to shaft of stone. Shaft extends on other side and is keyed for hand crank. Motor operates on 110 volts a.c. or d.c., is incased in weatherproof housing, drives wheel at 60 r.p.m. Container for wet grinding. Fleming Electric Tool Division, Loring Coes Co., Worcester, Mass.

Correction

The accompanying illustration erroneously appeared under the heading "Thermometers" on page 44 of the January, 1934, number. It should have been associated with the item entitled, "Flow Meters," on the same page, and is a product of the Republic Flow Meters Co., Chicago, not of the Jas. P. Marsh Corp., Chicago, as appeared.



Relays

Instantaneous and time-delay plunger-type, for protection against overcurrent and undervoltage, and for use as auxiliary relays. Operation depends upon action of magnet coil in attracting or releasing plunger when predetermined values of voltage or current are present in coil circuit. All single-pole. Placing poppet in proper hole changes to instantaneous overcurrent relay from time delay on contact opening, contact closing, or both. By turn of cap, air intake or out-take to bellows can be regulated to change time delay in opening or closing of contacts. Rubber bellows. General Electric Co., Schenectady, N. Y.

Spring Winder

Hand operated. Steel construction. Capacity $\frac{1}{4}$-in. wire, $\frac{5}{8}$-in. pitch, $1\frac{1}{8}$-in. diameter mandrell. Winder held in vise during use. Will coil either compression or extension spring with same setting. Takes any length of wire. John Blaner, 629 Meek St., Sharon, Pa.

Motor

Small, two-pole, with center drive construction. Type PM. Single-phase, induction, shaded coil type. For applications where little power and starting torque are required. A.C. current only. Oil-less bearings. Develops 1/1,000 hp. with full load speed 2,300 r.p.m. Weighs $1\frac{1}{4}$ lb. Available with and without gear reduction, ratios 27.67-1 and 48-1. Signal Electric Mfg. Co., Menominee, Mich.

Tube Fastenings

For surface condenser, cooler, and heater tubes. Called "John Crane." Two types, for use on inlet end. One type makes use of gasket inserted into bottom of drilling, soft Admiralty metal cone slipped over tube against gasket, hard Admiralty metal seat slipped into cone. Streamline ferrule is screwed against seat flush with tube sheet. Other type consists of gasket, cone, and special ferrule which is beveled to replace seat and ferrule in first type. Crane Packing Co., 1800 Cuyler Ave., Chicago.

TRADE LITERATURE

AIR PREHEATER—Bulletin No. 933, illustrates applications of the Ljungström air preheater.—The Air Preheater Corp., 60 E. 42d St., New York.

BEARINGS—Booklet, 8 pages, "An Outline of History for Anti-Friction Bearings."—The Fafnir Bearing Co., New Britain, Conn.

BEARINGS — Engineering Journal, 258 pages, types of bearings, technical data on ratings, load calculations, bearing selection and mounting, use and maintenance.—Timken Roller Bearing Co., Canton, Ohio.

BUSHINGS—Bulletin No. 339, "Johnson Phosphor Bronze Bushings, Standard Stock Sizes—Ready for Machine Assembly." — Johnson Bronze Co., New Castle, Pa.

CABLE—Leaflet, describes four types of Trenchlay Cable.—General Cable Corp., 420 Lexington Ave., New York.

CAPACITORS—Bulletin No. 710, "Ideal Capacitors for Power Factor Correction."—The Ideal Electric & Mfg. Co., Mansfield, Ohio.

CASTINGS — Bulletin B-1, 16 pages, "Elesco Bronze Castings."—The Superheater Co., Bronze Foundry Division, East Chicago, Ind.

CIRCUIT BREAKERS—Catalog pages 112A to 112D, "Bryant Type H Sentinel Circuit Breakers." — The Bryant Electric Co., Bridgeport, Conn.

COMPRESSORS — Bulletin L-612-B1A, "Worthington Feather Valve Compressors." Horizontal Duplex Motor-Driven. Direct-connected and Belted.—Worthington Pump and Machinery Corp., Harrison N. J.

COMPRESSOR—Bulletin 1133, "Carbondale Combined Units with Duplex Vertical Ammonia Compressors."—The Carbondale Machine Co., Carbondale, Pa.

CONCRETE — Folders, "Armored Concrete—Smashing Blows Do Not Even Scratch It!" and "Parts of Structures Subject to Impact and Abrasion, Those Are the Places for Armored Concrete." Also "Armored Concrete—Catalogue IV."—Armored Concrete Corp., Newark, N. J.

COUPLINGS—Catalog, illustrates and describes various kinds of flexible shaft couplings.—Poole Foundry & Machine Co., Woodbery, Baltimore, Md.

ELECTRODE—Bulletin, 2 pages, "Ferroweld, an Electrode for Welding Cast Iron."—The Lincoln Electric Co., Cleveland.

FLEXIBLE SHAFT MACHINES — Catalog, 64 pages, "New Ball-Bearing Line of Flexible Shaft Machines."—N. A. Strand & Co., 5001 N. Lincoln St., Chicago.

FURNACE—Catalog No. 345, "Belt-Conveyer Type Electric Furnace."—W. S. Rockwell Co., 50 Church St., New York.

(Continued on advertising page 78)

Data Sheet

Expansion Bolts

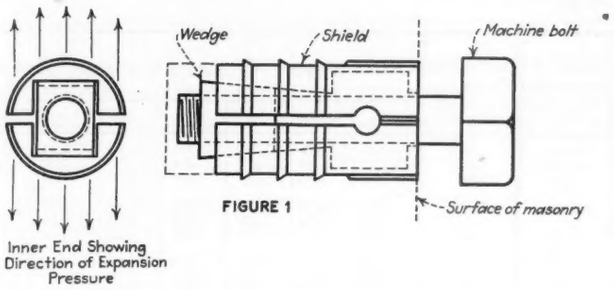


FIGURE 1

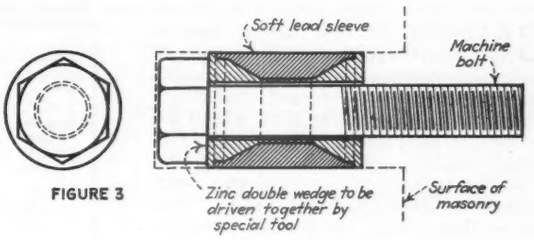


FIGURE 3

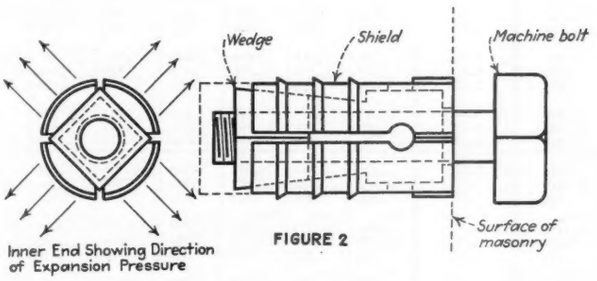


FIGURE 2

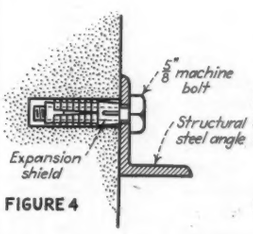


FIGURE 4

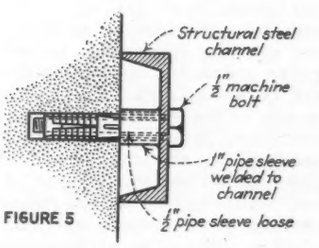


FIGURE 5

EXPANSION bolts for attaching machinery, shelving, fire escapes, ladders, canopies, wheel guards, and the like to masonry are steadily increasing in favor with factory-construction and maintenance men. This is the result of two conditions: first, manufacturers are diversifying their bolt designs to fit all situations; and, second, the proper application of such bolts is becoming better understood by users.

Built-in anchor bolts, as contrasted with expansion bolts, have several serious drawbacks:

1. Their location must be determined in advance of building.
2. Unless set by skilled craftsmen and subsequently guarded against displacement, they are pretty certain to be inaccurate.
3. They complicate concrete form work.
4. Once set, they cannot be altered or adjusted.

The type of machinery requiring anchorage cannot always be determined when the factory walls are started. A certain amount of "cut and try" is usually necessary properly to correlate the various mechanisms. The common expedients of drilling for anchors through walls or floors, of setting bolts in grout, lead, or sulphur, or of tearing out a block of masonry to build in an anchor are frequently not practicable or economical.

The modern expansion bolt consists of a steel bolt—usually a common machine bolt—and an expanding sleeve called a "shield." The primary function of the shield is to provide a mechanical bond or grip between the bolt and the adjacent masonry. Since a dependable metal-to-metal joint between the shield and the bolt can be simply made; the critical point is the bond between the shield and the masonry surface. Upon it alone, usually, depends the security of the entire anchorage.

Kinds of Expansion Bolts

Expansion bolts may be classified in several ways:

1. By the manner in which the shield expands; namely, two-way, four-way, or annular.
2. By the materials of which the shields are made.

A "hard" metal shield, usually malleable iron, is calculated to indent the masonry rather than to be deformed itself. A "soft" shield of lead, rubber, or other semi-plastic is forced by the expanding element into all the minute surface irregularities of the hole in the masonry.

3. By the manner in which the expanding wedge is tightened, whether by the bolt threads or by calking with a special tool. A calked shield will allow the bolt to be loosened without endangering the security of the anchorage—frequently a desirable quality.

4. Expansion bolts, both hard and soft, may also be separated into "end" expanding and "parallel" expanding. Where there is danger of splitting the masonry near the surface, the end-expanding type is better. Where the masonry is firm, or where a heavy shearing load is to be resisted, the parallel kind is preferable.

Figures 1 and 2 show hard-metal expansion bolts of the two- and four-way, end-expanding types. Figure 3 pictures a typical soft-metal bolt with calked, parallel expansion. Figures 4 and 5 indicate how wedge expansion does not tend to pull the fastening outward if the shield bears on the part to be held. Figure 5 illustrates the detail necessary if the hole in the masonry must be drilled after the structural member is in position.

Where the outer course of a brick wall is soft and a grip on the solid interior masonry is essential, a shield installed as in Figure 6 is good practice. It should be noted particularly in this case that the pipe sleeve must extend from the end of the shield to the face of the wall.

Failure of Expansion Bolts

An expansion bolt, though well tightened, may pull out, due to failure of the bond. Thus, a hard shield may crush to powder the inside surface of the hole, or a soft shield may be unable to grip a surface that is very smooth and hard. The remedy is the use of a

(Continued on page 92)

Data Sheet

Preferred Series for Incentive Rates

CHANGES in the labor market necessitate numerous adjustments in basic pay rates. Such changes cause burdensome calculations and changes in records in any incentive plan which involves the expression of piece prices in dollar values.

To overcome this objection, the practice of expressing all rates in time rather than dollar values was adopted and the accompanying table constructed to enable rapid conversion of any time rate to corresponding dollar value by direct selection from tabulated values.

In the third column from the left, time values from 1.00 to 10.00 are arranged in geometrical progression to give constant differential between successive values of approximately 3 per cent (.02996 is used to give an integral number to the series). A time value as determined from a time study may, therefore, be adjusted to one of these values with a maximum error of 1½ per cent, which is well within the range of accuracy of time study as practised in industry. Therefore we now express all our rates in time values to correspond to the nearest values in this preferred series.

The corresponding dollar value of the rate may be read in the column to the right headed by the appropriate base rate. For time values below 1 and above 10, the decimal point in the dollar value of the rate is shifted the same number of digits as required for the time value. For example,

1.30 hr./M @ $.40 base = $.52/M
13.0 hr./M = $.522/M

(Apparent error in multiplying is due to reduction of time values in preferred series to three significant figures.)

Experience with operatives using rates expressed in time values shows a demand for an expression of the number of pieces per hour on highly repetitive work. 588 pieces per hour means more to the average operative than .0017 hour per piece or 1.70 hours per M pieces. The first column, therefore, gives production per hour for the operative making his base rate, and column 2 gives production per hour for the average operative who can make 25 per cent over the base rate.

The preferred series illustrated, with 78 terms, gives sufficiently accurate results without too bulky a table. Series with more or less terms, as required, may be constructed if desired.

•

W. F. LENT, Production Manager
Cutler-Hammer, Inc.

Pieces per hour times 1 or 100 or 1,000 for rates respectively per Pc. or C or per M

To equal base rate prod. at ratio 100	Expected of aver. operator prod. at ratio 125	Decimal hrs. std. per Pc. or per C or per M	Rate per piece per C or per M at given base rate						
			.25	.26	.29	.30	.32	.34	.35
1.000	1.250	1.00	.250	.260	.290	.300	.320	.340	.350
.971	1.214	1.03	.257	.268	.299	.309	.330	.350	.360
.943	1.179	1.06	.265	.276	.307	.318	.339	.361	.371
.915	1.144	1.09	.273	.284	.316	.328	.349	.372	.382
.889	1.111	1.13	.281	.293	.328	.338	.362	.382	.394
.863	1.079	1.16	.290	.301	.336	.348	.371	.394	.406
.838	1.047	1.19	.298	.310	.345	.358	.381	.406	.418
.813	1.016	1.23	.307	.320	.356	.369	.394	.418	.430
.790	.987	1.27	.317	.329	.368	.380	.406	.430	.443
.767	.959	1.30	.326	.339	.377	.391	.416	.443	.456
.744	.930	1.34	.336	.349	.389	.403	.429	.457	.470
.723	.904	1.38	.346	.360	.400	.415	.442	.471	.484
.702	.877	1.43	.356	.371	.415	.428	.458	.484	.499
.681	.851	1.47	.367	.382	.426	.440	.470	.499	.514
.661	.826	1.51	.378	.393	.438	.454	.483	.514	.529
.642	.802	1.56	.389	.405	.452	.467	.499	.529	.545
.624	.780	1.60	.401	.417	.464	.481	.512	.545	.561
.605	.756	1.65	.413	.429	.478	.496	.528	.562	.578
.588	.735	1.70	.425	.442	.493	.510	.544	.578	.595
.571	.714	1.75	.438	.456	.507	.526	.560	.596	.613
.554	.692	1.81	.451	.469	.525	.541	.579	.614	.632
.538	.672	1.86	.465	.483	.539	.558	.595	.632	.651
.522	.652	1.91	.479	.498	.554	.574	.611	.651	.670
.507	.634	1.97	.493	.513	.571	.592	.630	.670	.690
.492	.615	2.03	.508	.528	.589	.609	.650	.691	.711
.478	.597	2.09	.523	.544	.606	.628	.669	.711	.732
.464	.580	2.15	.539	.560	.623	.646	.688	.732	.754
.451	.564	2.22	.555	.577	.644	.666	.710	.754	.777
.438	.547	2.29	.571	.594	.664	.686	.733	.777	.800
.425	.531	2.35	.588	.612	.681	.706	.752	.800	.824
.413	.516	2.42	.606	.630	.702	.727	.774	.824	.849
.400	.500	2.50	.624	.649	.725	.749	.800	.849	.874
.389	.486	2.57	.643	.669	.745	.772	.822	.874	.900
.378	.472	2.65	.662	.689	.768	.795	.848	.901	.927
.367	.459	2.73	.682	.709	.792	.818	.874	.928	.955
.356	.445	2.81	.702	.731	.815	.843	.899	.955	.983
.346	.432	2.89	.724	.752	.838	.868	.925	.984	1.013
.335	.419	2.98	.745	.775	.864	.894	.954	1.014	1.043
.326	.407	3.07	.768	.798	.890	.921	.982	1.044	1.075
.316	.395	3.16	.791	.822	.916	.949	1.011	1.075	1.107
.307	.384	3.28	.814	.847	.951	.977	1.050	1.107	1.140
.298	.372	3.35	.839	.872	.971	1.006	1.072	1.140	1.174
.290	.362	3.46	.864	.898	1.003	1.036	1.107	1.175	1.209
.281	.351	3.56	.890	.925	1.032	1.068	1.139	1.210	1.245
.273	.341	3.67	.916	.953	1.064	1.100	1.174	1.246	1.283
.265	.331	3.78	.944	.981	1.096	1.132	1.210	1.283	1.321
.257	.321	3.89	.972	1.011	1.128	1.166	1.245	1.322	1.361
.250	.312	4.00	1.001	1.041	1.160	1.201	1.280	1.361	1.402
.242	.302	4.12	1.031	1.072	1.195	1.237	1.318	1.402	1.444
.235	.294	4.25	1.062	1.104	1.232	1.274	1.360	1.444	1.487
.229	.286	4.38	1.094	1.138	1.270	1.313	1.402	1.487	1.531
.222	.277	4.51	1.127	1.172	1.308	1.352	1.443	1.532	1.577
.215	.269	4.64	1.160	1.207	1.346	1.392	1.485	1.578	1.624
.209	.261	4.78	1.195	1.243	1.386	1.434	1.530	1.625	1.673
.203	.254	4.92	1.231	1.280	1.427	1.477	1.574	1.674	1.723
.197	.246	5.07	1.268	1.319	1.470	1.521	1.622	1.724	1.775
.191	.239	5.22	1.306	1.358	1.514	1.567	1.670	1.776	1.828
.186	.232	5.38	1.345	1.399	1.560	1.614	1.722	1.829	1.883
.181	.226	5.54	1.385	1.441	1.607	1.662	1.773	1.884	1.939
.175	.219	5.71	1.427	1.484	1.656	1.712	1.827	1.940	1.997
.170	.212	5.88	1.469	1.528	1.705	1.763	1.882	1.999	2.057
.165	.206	6.05	1.513	1.574	1.754	1.816	1.936	2.058	2.119
.160	.200	6.24	1.559	1.621	1.810	1.871	1.997	2.120	2.182
.156	.195	6.42	1.605	1.670	1.862	1.927	2.054	2.183	2.248
.151	.189	6.61	1.654	1.720	1.917	1.984	2.115	2.249	2.315
.147	.184	6.81	1.703	1.771	1.975	2.044	2.179	2.316	2.384
.143	.179	7.02	1.754	1.824	2.036	2.105	2.246	2.386	2.456
.138	.172	7.23	1.807	1.879	2.097	2.168	2.314	2.457	2.529
.134	.167	7.44	1.861	1.935	2.158	2.233	2.381	2.531	2.605
.130	.162	7.67	1.917	1.993	2.224	2.300	2.454	2.606	2.683
.127	.159	7.90	1.974	2.053	2.291	2.369	2.528	2.685	2.764
.123	.154	8.13	2.033	2.114	2.358	2.440	2.602	2.765	2.846
.119	.149	8.38	2.094	2.178	2.430	2.513	2.682	2.848	2.932
.116	.145	8.63	2.157	2.243	2.502	2.588	2.762	2.933	3.020
.113	.141	8.89	2.221	2.310	2.578	2.666	2.845	3.021	3.110
.109	.136	9.15	2.288	2.380	2.653	2.746	2.928	3.112	3.203
.106	.132	9.43	2.357	2.451	2.734	2.828	3.018	3.205	3.299
.103	.129	9.71	2.427	2.524	2.816	2.913	3.107	3.301	3.398
.100	.125	10.00	2.500	2.600	2.900	3.000	3.200	3.400	3.500

Data Sheet

Preferred Series for Incentive Rates

Rate per piece or per C or per M at given base rate

.37	.38	.39	.40	.42	.43	.44	.45	.46	.47	.48	.49	.50	.51	.52	.53	.54	.55	.58	.63
.370	.380	.390	.400	.420	.430	.440	.450	.460	.470	.480	.490	.500	.510	.520	.530	.540	.550	.580	.630
.381	.391	.402	.412	.433	.443	.453	.463	.474	.484	.494	.505	.515	.525	.536	.546	.556	.566	.597	.649
.393	.403	.414	.424	.446	.456	.466	.477	.488	.499	.509	.520	.530	.541	.552	.562	.572	.583	.615	.668
.404	.415	.426	.437	.459	.469	.480	.492	.503	.514	.524	.536	.545	.557	.568	.579	.589	.601	.632	.687
.416	.428	.439	.450	.473	.486	.498	.506	.517	.529	.540	.551	.565	.574	.585	.596	.610	.619	.655	.712
.429	.440	.452	.464	.487	.499	.510	.522	.533	.545	.556	.568	.580	.591	.603	.614	.626	.637	.673	.731
.442	.454	.466	.477	.501	.512	.524	.537	.549	.561	.573	.585	.595	.609	.621	.633	.643	.657	.690	.750
.455	.467	.480	.492	.516	.529	.541	.553	.566	.578	.590	.603	.615	.627	.640	.652	.664	.676	.713	.775
.468	.481	.494	.507	.532	.546	.559	.570	.582	.595	.608	.620	.635	.646	.658	.671	.686	.696	.737	.800
.482	.496	.509	.522	.548	.559	.572	.587	.600	.613	.626	.639	.650	.665	.678	.691	.702	.717	.754	.819
.497	.510	.524	.537	.564	.576	.590	.604	.618	.631	.645	.658	.670	.685	.698	.712	.724	.739	.777	.844
.512	.526	.540	.553	.581	.593	.607	.623	.637	.650	.664	.678	.690	.706	.720	.734	.745	.761	.800	.869
.527	.542	.556	.570	.599	.615	.629	.641	.655	.670	.684	.698	.715	.727	.741	.755	.772	.784	.829	.901
.543	.558	.573	.587	.616	.632	.647	.661	.675	.690	.705	.719	.735	.749	.763	.778	.794	.807	.853	.926
.559	.574	.590	.605	.635	.649	.664	.680	.696	.711	.726	.741	.755	.771	.786	.801	.815	.831	.876	.951
.576	.592	.607	.623	.654	.671	.686	.701	.716	.732	.747	.763	.780	.794	.810	.825	.842	.856	.905	.983
.593	.609	.626	.641	.674	.688	.704	.722	.738	.754	.770	.788	.800	.818	.834	.850	.864	.882	.928	1.008
.611	.628	.644	.661	.694	.709	.726	.743	.760	.776	.793	.809	.825	.842	.859	.876	.891	.908	.957	1.039
.629	.646	.663	.680	.715	.731	.748	.765	.782	.800	.817	.833	.850	.868	.885	.902	.918	.936	.986	1.071
.648	.666	.683	.701	.736	.752	.770	.788	.806	.824	.841	.858	.875	.894	.911	.929	.945	.964	1.015	1.102
.668	.686	.704	.722	.758	.778	.796	.812	.830	.848	.866	.884	.905	.920	.939	.957	.977	.993	1.050	1.140
.688	.706	.725	.743	.781	.800	.818	.837	.855	.874	.892	.911	.930	.948	.967	.985	1.004	1.022	1.079	1.172
.708	.727	.746	.766	.804	.821	.840	.861	.880	.900	.919	.938	.955	.976	.995	1.014	1.031	1.053	1.108	1.203
.730	.749	.769	.789	.828	.847	.867	.887	.907	.927	.946	.966	.985	1.006	1.025	1.045	1.064	1.084	1.143	1.241
.751	.772	.792	.812	.853	.873	.893	.914	.934	.954	.975	.995	1.015	1.036	1.056	1.076	1.096	1.117	1.177	1.279
.774	.795	.816	.837	.879	.899	.920	.941	.962	.983	1.004	1.025	1.045	1.067	1.088	1.109	1.129	1.150	1.212	1.317
.797	.819	.840	.862	.905	.924	.946	.969	.991	1.013	1.034	1.055	1.075	1.099	1.120	1.142	1.161	1.185	1.247	1.354
.821	.843	.865	.888	.932	.955	.977	1.999	1.021	1.043	1.065	1.087	1.110	1.132	1.154	1.176	1.199	1.220	1.288	1.399
.845	.868	.891	.914	.960	.985	1.008	1.028	1.051	1.074	1.097	1.120	1.145	1.166	1.188	1.211	1.237	1.257	1.328	1.443
.871	.894	.918	.942	.989	1.010	1.034	1.059	1.083	1.106	1.130	1.153	1.175	1.200	1.224	1.248	1.269	1.295	1.363	1.480
.897	.921	.945	.970	1.018	1.041	1.065	1.091	1.115	1.139	1.164	1.188	1.210	1.236	1.260	1.285	1.307	1.333	1.404	1.525
.924	.949	.974	.999	1.049	1.075	1.100	1.124	1.149	1.174	1.199	1.224	1.250	1.273	1.298	1.323	1.350	1.373	1.450	1.575
.952	.977	1.003	1.029	1.080	1.105	1.130	1.157	1.183	1.209	1.234	1.260	1.285	1.312	1.337	1.363	1.388	1.414	1.491	1.619
.980	1.007	1.033	1.060	1.113	1.139	1.166	1.192	1.219	1.245	1.271	1.298	1.325	1.351	1.377	1.404	1.431	1.457	1.537	1.669
1.009	1.037	1.064	1.091	1.146	1.174	1.201	1.228	1.255	1.282	1.310	1.337	1.365	1.391	1.419	1.446	1.474	1.501	1.583	1.720
1.040	1.068	1.096	1.124	1.180	1.208	1.236	1.264	1.293	1.321	1.349	1.377	1.405	1.433	1.461	1.489	1.517	1.545	1.630	1.770
1.071	1.100	1.129	1.158	1.216	1.243	1.272	1.302	1.331	1.360	1.389	1.418	1.445	1.476	1.505	1.534	1.561	1.592	1.676	1.821
1.103	1.133	1.163	1.192	1.252	1.281	1.311	1.341	1.371	1.401	1.431	1.461	1.490	1.520	1.550	1.580	1.609	1.640	1.728	1.877
1.136	1.167	1.197	1.228	1.289	1.320	1.351	1.381	1.412	1.443	1.474	1.504	1.535	1.566	1.596	1.627	1.658	1.689	1.781	1.934
1.170	1.202	1.233	1.265	1.328	1.359	1.390	1.423	1.455	1.486	1.518	1.549	1.580	1.613	1.644	1.676	1.706	1.739	1.833	1.991
1.205	1.238	1.270	1.303	1.368	1.410	1.443	1.466	1.498	1.531	1.563	1.596	1.640	1.661	1.694	1.726	1.771	1.791	1.902	2.066
1.241	1.275	1.308	1.342	1.409	1.440	1.474	1.509	1.543	1.577	1.610	1.643	1.675	1.711	1.744	1.778	1.809	1.845	1.943	2.110
1.278	1.313	1.347	1.382	1.451	1.488	1.522	1.555	1.589	1.624	1.658	1.693	1.730	1.762	1.797	1.831	1.868	1.900	2.007	2.180
1.316	1.352	1.388	1.423	1.495	1.531	1.566	1.601	1.637	1.672	1.708	1.743	1.780	1.815	1.850	1.886	1.922	1.957	2.065	2.243
1.356	1.393	1.429	1.466	1.539	1.578	1.615	1.649	1.686	1.723	1.759	1.796	1.835	1.869	1.906	1.942	1.982	2.016	2.129	2.312
1.397	1.434	1.472	1.510	1.585	1.625	1.663	1.699	1.736	1.774	1.812	1.850	1.890	1.925	1.963	2.001	2.041	2.076	2.192	2.381
1.439	1.477	1.516	1.555	1.633	1.673	1.712	1.750	1.788	1.827	1.866	1.905	1.945	1.983	2.022	2.061	2.101	2.138	2.256	2.451
1.481	1.522	1.562	1.602	1.682	1.720	1.760	1.802	1.842	1.882	1.922	1.962	2.000	2.042	2.082	2.122	2.160	2.202	2.320	2.520
1.526	1.567	1.608	1.650	1.732	1.772	1.813	1.856	1.897	1.938	1.980	2.021	2.060	2.103	2.144	2.186	2.225	2.268	2.390	2.596
1.572	1.614	1.657	1.699	1.784	1.827	1.870	1.912	1.954	1.997	2.039	2.082	2.125	2.166	2.209	2.251	2.295	2.336	2.465	2.677
1.619	1.663	1.706	1.750	1.838	1.883	1.928	1.969	2.012	2.056	2.100	2.144	2.190	2.231	2.275	2.319	2.365	2.406	2.540	2.759
1.667	1.712	1.757	1.803	1.893	1.939	1.984	2.028	2.073	2.118	2.163	2.208	2.255	2.298	2.343	2.388	2.435	2.479	2.616	2.841
1.717	1.764	1.810	1.857	1.949	1.995	2.042	2.088	2.135	2.181	2.228	2.274	2.320	2.367	2.413	2.460	2.506	2.553	2.691	2.923
1.769	1.817	1.864	1.912	2.008	2.055	2.103	2.151	2.199	2.247	2.295	2.342	2.390	2.438	2.486	2.533	2.581	2.629	2.772	3.011
1.822	1.871	1.920	1.969	2.068	2.116	2.165	2.216	2.265	2.314	2.363	2.413	2.460	2.511	2.560	2.610	2.657	2.708	2.854	3.100
1.876	1.927	1.978	2.028	2.130	2.180	2.231	2.282	2.333	2.383	2.434	2.485	2.535	2.586	2.637	2.688	2.738	2.789	2.941	3.194
1.933	1.985	2.037	2.089	2.194	2.245	2.297	2.350	2.403	2.455	2.507	2.559	2.610	2.664	2.716	2.768	2.819	2.873	3.028	3.289
1.991	2.044	2.098	2.152	2.259	2.313	2.367	2.421	2.475	2.528	2.582	2.636	2.690	2.744	2.798	2.851	2.905	2.959	3.120	3.389
2.050	2.105	2.161	2.216	2.327	2.382	2.438	2.493	2.549	2.604	2.660	2.715	2.770	2.826	2.881	2.937	2.992	3.047	3.213	3.490
2.112	2.169	2.226	2.283	2.397	2.455	2.512	2.568	2.625	2.682	2.739	2.796	2.855	2.910	2.968	3.025	3.083	3.139	3.312	3.597
2.175	2.234	2.292	2.351	2.469	2.528	2.587	2.645	2.704	2.763	2.821	2.880	2.940	2.998	3.057	3.115	3.175	3.233	3.410	3.704
2.240	2.300	2.361	2.422	2.543	2.601	2.662	2.724	2.785	2.845	2.906	2.966	3.025	3.087	3.148	3.209	3.267	3.330	3.509	3.811
2.307	2.369	2.432	2.494	2.619	2.683	2.746	2.806	2.868	2.931	2.993	3.055	3.120	3.180	3.242	3.305	3.370	3.429	3.619	3.931
2.376	2.440	2.505	2.569	2.697	2.761	2.825	2.890	2.954	3.018	3.083	3.147	3.210	3.275	3.339	3.404	3.467	3.532	3.724	4.045
2.447	2.513	2.579	2.646	2.778	2.842	2.908	2.976	3.042	3.109	3.175	3.241	3.305	3.373	3.439	3.505	3.569	3.638	3.834	4.164
2.521	2.589	2.657	2.725	2.861	2.928	2.996	3.066	3.134	3.202	3.270	3.338	3.405	3.474	3.543	3.611	3.677	3.747	3.950	4.290
2.596	2.666	2.737	2.807	2.947	3.019	3.089	3.158	3.228	3.298	3.368	3.438	3.510	3.579	3.649	3.719	3.791	3.859	4.072	4.423
2.674	2.746	2.819	2.891	3.035	3.109	3.181	3.252	3.324	3.397	3.469	3.541	3.615	3.686	3.758	3.830	3.904	3.975	4.193	4.555
2.754	2.828	2.903	2.977	3.126	3.199	3.274	3.349	3.424	3.498	3.573	3.647	3.720	3.796	3.870	3.945	4.018	4.094	4.315	4.687
2.836	2.913	2.990	3.067	3.220	3.298	3.375	3.450	3.526	3.603	3.680	3.756	3.835	3.910	3.986	4.063	4.142	4.217	4.449	4.832
2.922	3.001	3.079	3.158	3.316	3.397	3.476	3.553	3.632	3.711	3.790	3.869	3.950	4.027	4.106	4.185	4.266	4.343	4.582	4.977
3.009	3.090	3.172	3.253	3.413	3.496	3.577	3.660	3.741	3.822	3.904	3.985	4.065	4.148	4.229	4.310	4.390	4.473	4.715	5.122
3.099	3.183	3.267	3.351	3.518	3.603	3.687	3.769	3.853	3.937	4.021	4.104	4.190	4.272	4.356	4.439	4.525	4.607	4.860	5.279
3.192	3.278	3.365	3.451	3.623	3.711	3.797	3.882	3.968	4.055	4.141	4.227	4.315	4.400	4.486	4.572	4.660	4.745	5.005	5.437
3.288	3.377	3.466	3.554	3.732	3.823	3.912	3.999	4.088	4.176	4.265	4.354	4.444	4.532	4.621	4.710	4.801	4.887	5.156	5.601
3.386	3.478	3.569	3.661	3.844	3.934	4.026	4.118	4.210	4.301	4.393	4.484	4.575	4.667	4.759	4.851	4.941	5.034	5.307	5.764
3.488	3.582	3.676	3.770	3.959	4.055	4.149	4.242	4.336	4.430	4.525	4.619	4.715	4.807	4.902	4.996	5.092	5.184	5.469	5.941
3.592	3.689	3.787	3.883	4.078	4.175	4.272	4.369	4.466	4.563	4.660	4.757	4.855	4.951	5.049	5.146	5.243	5.340	5.632	6.117
3.700	3.800	3.900	4.000	4.200	4.300	4.400	4.500	4.600	4.700	4.800	4.900	5.000	5.100	5.200	5.300	5.400	5.500	5.800	6.300

Data Sheet

Expansion Bolts

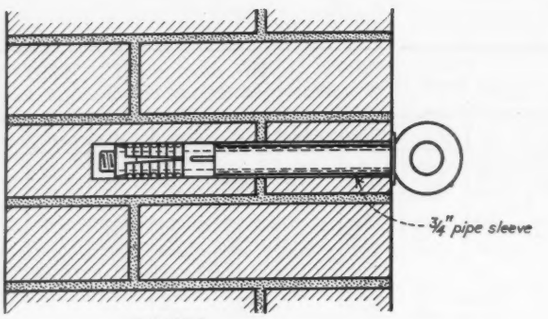


FIGURE 6

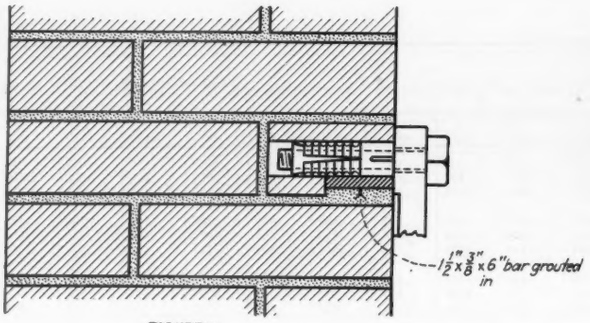


FIGURE 7

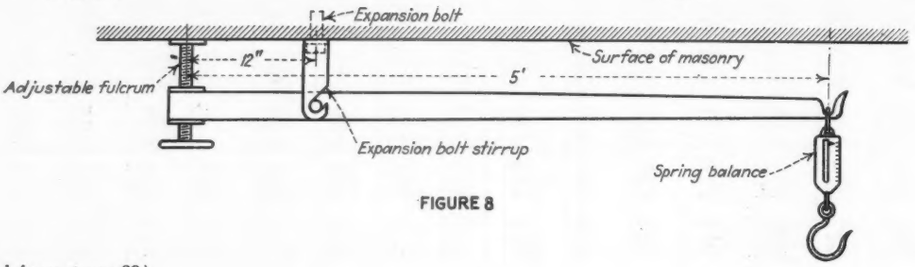


FIGURE 8

(Continued from page 89)

longer or a larger shield, or the change from hard to soft, or vice versa.

Sometimes the masonry may be split or lifted by the expansive action of the bolt, due either to insufficient weight above or to lateral weakness of the masonry. A two-way hard bolt can localize the pressure of expansion in the direction of the greatest strength of the masonry.

When the shearing load on a bolt is excessive, the shield may crush out the masonry near the surface. The remedy here may be: (1) a larger shield, (2) a flat piece of steel grouted under the shield as shown in Figure 7, or (3) the use of some hard cementing material around the outer end of the shield after cutting away some of the masonry to provide a larger bearing area.

Drilling the Hole and Setting the Bolt

The most expensive element in the use of expansion bolts is the drilling of the holes in the masonry. Where only a few holes are required, the standard four-point, diamond-point, twist-drill, or extension-drill head used with a hand hammer will be found economical. However, if a number of holes are to be drilled, an air or electric percussion hammer will cut the drilling time.

A fundamental requirement of rapid drilling with a percussion drill is to utilize the driller's weight or the upward pressure of his knees from a ladder rather than to expect him to push the drill with his arms. Accordingly, good ladders and staging are essential. Adequate illumination and goggles contribute to fast work.

The size of drill is important since the shield should have a light driving fit in the hole.

There has been considerable adverse criticism of hard-metal shields when installed where there is vibration. If, after such a bolt has been in place a few days, it is again tightened, it will then resist vibration much better. Incidentally, a skillful driller using a percussion hammer can so enlarge the inner end of a hole that the chance of a bolt pulling out is remote, even though the bolt should become loose.

Testing

Figure 8 shows a simple lever device for testing expansion bolts against pulling out. The actual tension on the bolt is about five times the pull indicated by the spring balance, making the practical capacity of the device about 1,000 pounds.

The ideal of the bolt maker is to provide a gripping power in his device so great that it will fail by fracture of the bolt rather than by damage to the masonry. The table indicates working and ultimate strengths in direct tension of common bolts themselves. Obviously these would be the maximum strength of any anchorages using such bolts. The factory man studying expansion bolts for an installation will scale down these values perhaps to a half or even a tenth, using his judgment as to the effect of deterioration, corrosion, moisture, vibration, neglect, and the quality of the masonry.

Strengths of Common Bolts in Tension

Diameter	Working Load	Ultimate Strength
¼ in.	400 lb.	1,500 lb.
⅜ "	1,000 "	3,700 "
½ "	1,900 "	7,000 "
⅝ "	3,000 "	11,000 "
¾ "	4,500 "	17,000 "
⅞ "	6,300 "	23,000 "
1 "	8,300 "	30,000 "

▼

F. D. Hartford, Denver, Colo.

Hills for Gold?

that power could be purchased during periods of warm weather to especial advantage, while the use of a noncondensing turbine would provide new economies during cold weather.

Superintendent E. G. Bayles writes: "Our annual operating costs have been reduced 40 per cent, the turbine alone saving more than $7,000 yearly."

NEW MOTORS SAVE PAPER MILL $3,800 ANNUALLY

The California Fruit Wrapping Paper Mills, Inc., found that it could save $3,800 annually on its power bill by modernizing with G-E motors and control. Mr. F. O. Fernstrom writes: "We find the expected savings have been exceeded and represent thirty-four-per-cent return on the investment."

INVESTED AT 70 PER CENT

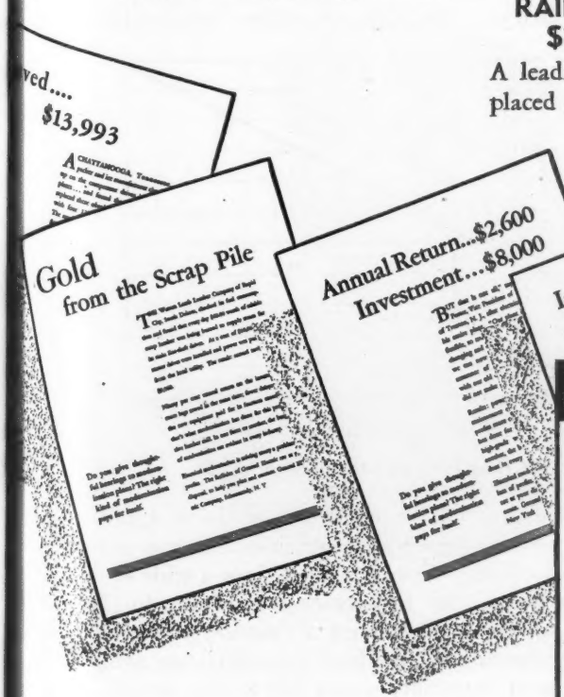
The North Carolina Finishing Company replaced its old power-plant equipment with a G-E turbine to provide power and process steam. Mr. Julian Robertson, general manager, says: "Installation cost was $19,200 including engineering, and under present operating conditions the saving is at the rate of $13,500 annually. In figuring this saving, we have included the cost of labor for operating the turbine and a generous allowance for depreciation of the equipment."

RAILROAD SHOP SAVES $12,780 ANNUALLY

A leading southeastern railroad replaced its obsolete drives with General Electric motors and control. Modern synchronous-motor-driven compressors were installed, and power was purchased from the local utility company. Result: increased production at lower cost; cleaner, lighter, and better shops; and a fifty-per-cent return on the initial investment.

MECHANICAL-DRIVE TURBINE SAVES $3,761 ANNUALLY

A large New England department store installed a G-E mechanical-drive turbine to supply power to a refrigerating compressor. This turbine operates on the exhaust steam from a group of reciprocating engines. The result—an annual saving of $3,761. Are you getting the most out of steam? Perhaps somewhere in your plant the available energy in steam is not being fully utilized. Why not investigate?



Send for "MODERNIZATION PAYS"

General Electric Company
Dept. 6A-201, Schenectady, N. Y.
Gentlemen:

Please send me a copy of your booklet, "Modernization Pays," GEL-448, which contains many interesting examples of money-making modernization.

NAME .....

COMPANY .....

ADDRESS .....

011-2

Down Go Floor Maintenance Costs When You Use *"A-W" Rolled Steel Floor Plate*

YOU can lay a beautifully smooth floor—but can you keep it that way? You can patch broken surfaces and worn spots—but can you make the patches stick?

Protect new floors—repair old floors—with "A-W" Rolled Steel Floor Plate. Readily and securely laid over any type flooring—cut to fit wherever necessary—used as runners or to cover large surfaces.

"A-W" Rolled Steel Floor Plate, standard *Diamond* or *Diamondette* pattern, is economical, wears for years, provides excellent traction, speeds trucking, prevents accidents. It is laid quickly, at astonishingly low cost. Reduces floor maintenance to the practical minimum.

Let us tell you more about it.

ALAN WOOD STEEL CO.

108 Years Iron and Steel Making Experience

CONSHOHOCKEN, PA.

BRANCHES: Philadelphia, Pa., Fidelity-Philadelphia Trust Bldg.; New York, N. Y., 60 E. 42nd St.; Boston, 250 Stuart St.; Los Angeles, 620 W. McGarland Bldg.; San Francisco, 444 Market St.; Seattle, 4535 5th Ave., N.E.

REPRESENTATIVES: Buffalo, F. E. Allen, Inc.; Pittsburgh, C. C. Poling Co.; Detroit, G. C. Davies Co.; Cleveland, J. F. Corbett & Co.; Chicago, A. M. Castle & Co.; Houston, I. Van Tassel, P. O. Box 732.; New Orleans, Jones & Laughlin Steel Corp.; Birmingham, J. H. Scruggs Co.; Minneapolis, R. E. Deutsche Co.

(Continued from editorial page 61)

Let us assume for a minute that our productive activities are $600 a week and that they are slowly rising until they reach $1,200 a week. Now according to the chart our expenses at $600 a week should be $1,220 and at $1,200 a week should be $1,710, or an increase of $490, which is the sum of the several accounts. This spread of $490 would be equivalent to a variable increase of approximately 82c. But we are using a variable of 50c. What accounts for the difference? We have said on our chart that at $1,000 productive load expenses will arbitrarily be increased $181 (point *B*). The increase may not take place at this point. It may happen sooner or later or it may not happen at all if the surge of productive output is of a temporary nature. The point I wish to emphasize is that when we reach $1,000 of productive load our

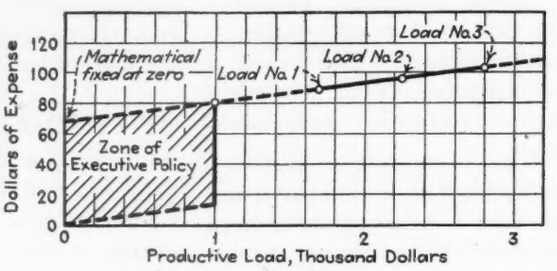


CHART 3—Salaried foremen

budget automatically tells management that a decision regarding this arbitrary increase of expense must be made. Of course, when we are going down the opposite condition prevails. The conditions that we have expressed, when applied to the several accounts included therein, show the same general situation. However, each type of account presents its own problems.

The actual control of expenses by this method should always be by the summation of detail control rather than by totals. This practice allows automatic weighing of the several factors. By this procedure relationships

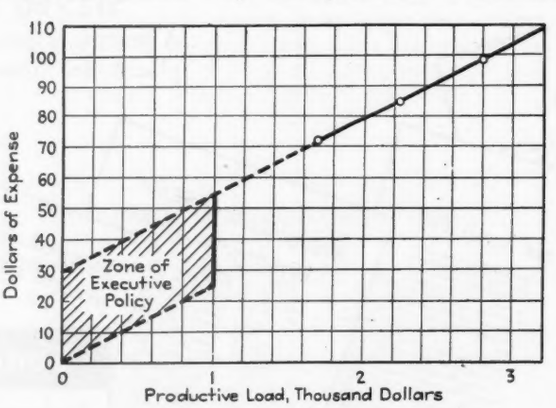


CHART 4—Hourly foremen

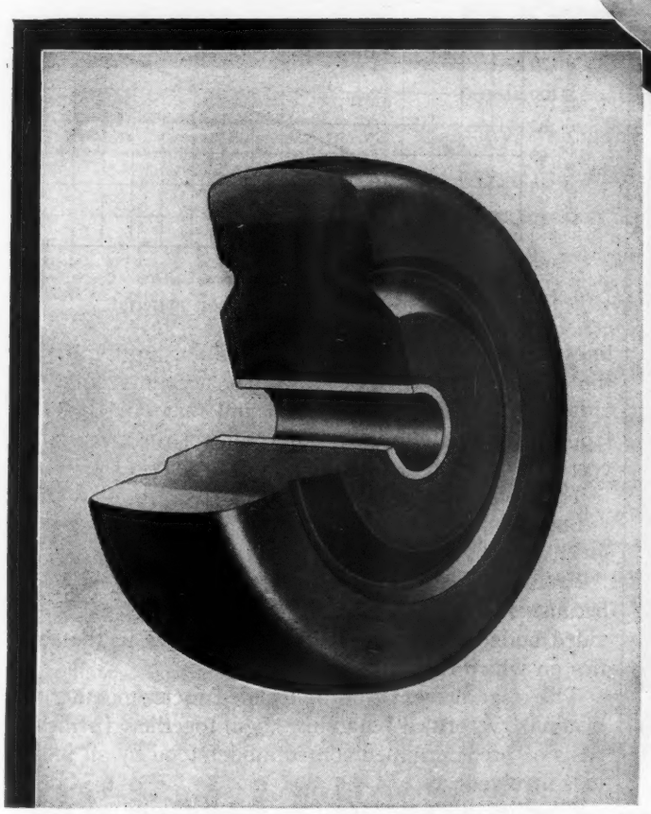
between periods are not distorted. A study of Charts 3 to 6 inclusive will show the peculiarities that can arise in individual accounts. Charts 3 and 4 show a wide zone of executive policy. In both cases this is due to the policy of beginning or contracting a function at a given time. Using the factors in Chart 4 to illustrate specifically, the line of variability shows $30 at zero activity; actually the expense would be zero. This means that around a low productive load ($1,000 in this case) a man

Bassick

TRUCK CASTER WHEELS FOR FLOOR PROTECTION

ATLASITE

One of the most important developments in truck caster wheels in many years. A non-metallic, non-brittle, *economical* wheel, more quiet than metal, easy on floors and with the same carrying capacity as a metal wheel. It has an extremely high resistance to abrasion and is resistant to water, oil and most acids. A wheel adaptable for use under practically any and all conditions.



BACO

The finest protective tread wheel available for light and medium duty service. Resilient tread of special high efficiency rubber with a tensile strength of 3500 lbs. per square inch. The tread will not come off the solid indestructible core. An easy rolling, quiet wheel which gives the maximum degree of floor protection.

These wheels of superior quality available in sizes 2" to 8" diameters in BASSICK TRUCK CASTERS. Write for complete information and catalog No. 110B.

THE BASSICK COMPANY

BRIDGEPORT CONNECTICUT

"The right caster and the correct wheel for every installation"

They're all
"TIMEPIECES"
but there's a difference!
The Chronometer is a timepiece . . . but of such superlative and unvarying PRECISION that other timepieces are "set" by comparison with it as a standard. . . . . In other mechanisms, too, PRECISION marks the same degree of superiority—sets a standard of comparison . . . IN BALL, ROLLER & THRUST BEARINGS, FOR EXAMPLE
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PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORPORATION
STAMFORD, CONN. U.S.A.

FACTS . . . ABOUT SKILSAW PERFORMANCE VS. HAND SAWING!
Actual tests prove that Skilsaws have 4 to 20 times the speed!
SKILSAW rips 60 ft. of 7/8" maple flooring in 3 minutes against 4 hours for hand sawing!
SKILSAW will cut off 22 ft. of 7/8" crating lumber per minute — 18 times as fast as hand sawing!
SKILSAW opens crates without touching goods, quickly paying for itself in crate salvage.
SKILSAW is absolutely accurate — used without effort—cuts wood, stone, metal and compositions.
Made in six powerful sizes for all industrial and maintenance work. Sales and service throughout the United States.
SKILSAW
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3318 Elston Ave.
Chicago
WRITE TODAY FOR OUR BOOKLET "SAWING FACTS"

will be placed on this job alone. Note that up to $1,000 load some allowance is made. At $600 load this allowance is $15 per week. As long as there is a productive load there is supervision of this type and, though it may not be considered as a specific function, some individual is performing the function along with his other duties. In most cases the regular supervisors would be assigned

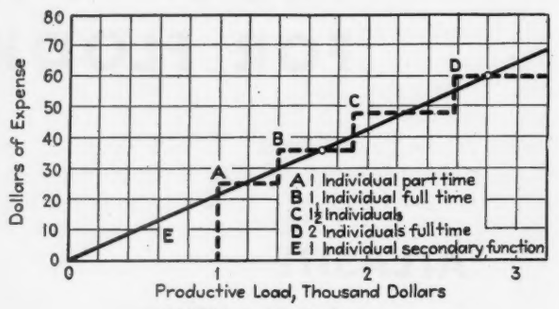

Dollars of Expense
Productive Load, Thousand Dollars
A 1 Individual part time
B 1 Individual full time
C 1½ Individuals
D 2 Individuals full time
E 1 Individual secondary function

CHART 5—Methods men

productive jobs for the major part of their time, spending what time is necessary to supervise. We call such split-time supervisors working leaders. They are common when production is so low that we cannot support full-time supervisors. That is why we have an allowance until the function is definitely established.

Chart 5 expresses a type of function that usually varies in steps. A study of the points *A* to *E* illustrates. Control can be built on either method (steps or straight line) but the use of the straight-line varibale gives the simpler set-up, especially when the account in question is to be combined with other accounts based on straight

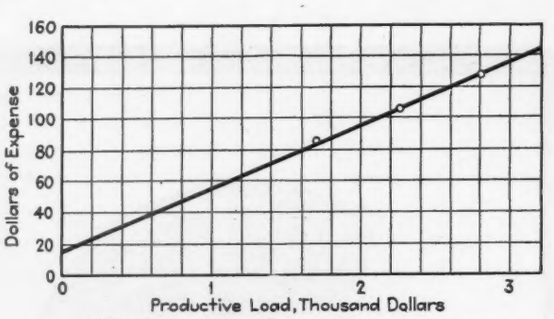


CHART 6—Miscellaneous shop material

lines. Following the practice of building up totals from the summation of the individual accounts, however, either method can be employed and that one should be employed which gives the better control for a reasonable cost.

To summarize, we believe that:

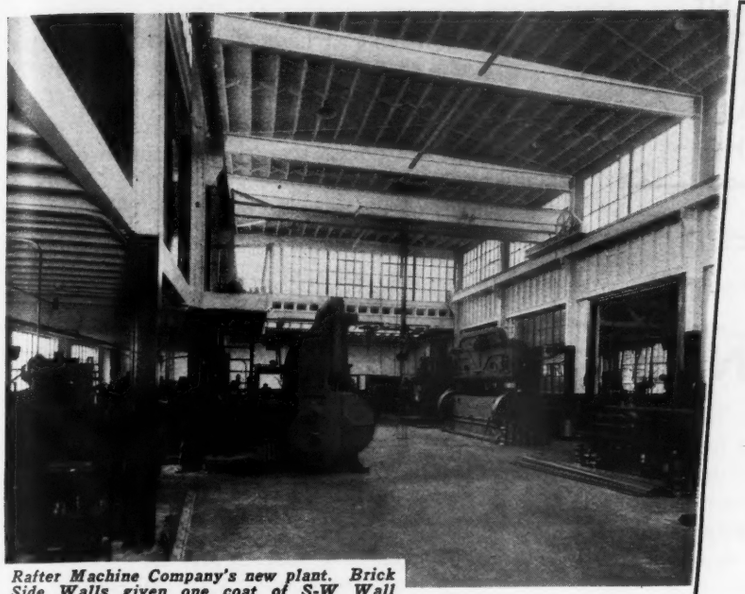
Static expense budgeting is unsatisfactory once it has given a cross-section of expected condition.

From a control point, static budgets are obsolete because for the same cost and effort there can be provided budgets that will follow the changes in the activities on which they are built.

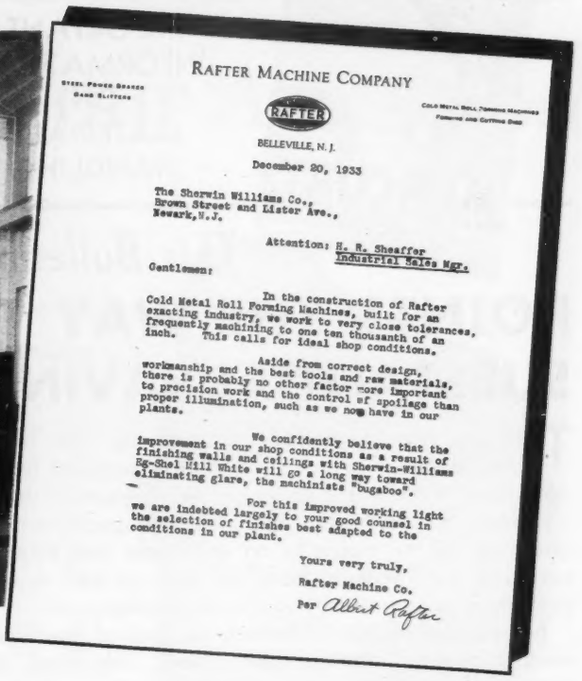
The clear presentation of isolated facts, together with a summary formed by adding them together, furnishes a basis of predetermined control understood by all individuals involved.

The linking together of several loads by an average or straight line relationship is sound, but modification and refinements of this procedure depend entirely upon

THE RIGHT MILL WHITE FOR BETTER LIGHT AND SIGHT



Rafter Machine Company's new plant. Brick Side Walls given one coat of S-W Wall Primer and Sealer. Balance not sealed. Covered solid with one coat of S-W Save-Lite Mill White.



RAFTER MACHINE COMPANY

Steel Power Brakes
Gang Slitters

RAFTER

Cold Metal Roll Forming Machines
Forming and Cutting Dies

BELLEVILLE, N. J.

December 20, 1933

The Sherwin Williams Co.,
Brown Street and Lister Ave.,
Newark, N.J.

Attention: H. R. Sheaffer
Industrial Sales Mgr.

Gentlemen:

In the construction of Rafter Cold Metal Roll Forming Machines, built for an exacting industry, we work to very close tolerances, frequently machining to one ten thousanth of an inch. This calls for ideal shop conditions.

Aside from correct design, workmanship and the best tools and raw materials, there is probably no other factor more important to precision work and the control of spoilage than proper illumination, such as we now have in our plants.

We confidently believe that the improvement in our shop conditions as a result of finishing walls and ceilings with Sherwin-Williams Eg-Shel Mill White will go a long way toward eliminating glare, the machinists "bugaboo".

For this improved working light we are indebted largely to your good counsel in the selection of finishes best adapted to the conditions in our plant.

Yours very truly,

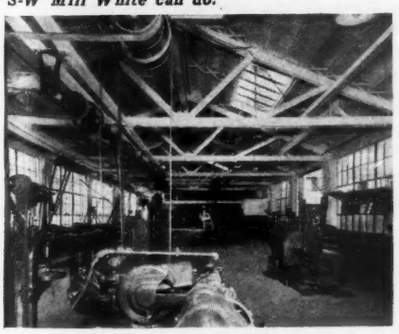
Rafter Machine Co.

Per Albert Rafter

Rafter Machine Company Plant at Belleville, N. J., before painting walls and ceilings with Sherwin-Williams Save-Lite Mill White.

•

Rafter Machine Company plant after one coat of Sherwin-Williams Eg-Shel Mill White, Eg-Shel finish. This shows what one coat of S-W Mill White can do.



S-W MILL WHITE HELPS CONTROL SPOILAGE FOR RAFTER MACHINE CO.!!

Again the customer tells our story for us. The Rafter Machine Company, like many other progressive concerns, finds Sherwin-Williams Save-Lite Mill White on walls and ceilings is low cost insurance against spoilage and accidents. It does what no ordinary white paint can do. Sherwin-Williams Mill White *softly diffuses* every ray of light, natural or artificial, into every corner and portion of rooms. Dangerous glare and deep shadows are eliminated. Spoilage is minimized—because workmen can see what they are doing.

Get This Test for Your Plant

Let us show you with scientific light and sight measuring instruments exactly how much Sherwin-Williams Mill White will improve and increase working light in your plant. This test costs you nothing—does not obligate you. Write The Sherwin-Williams Company, Dep't. 634, Cleveland, Ohio.

SHERWIN-WILLIAMS
SAVE-LITE MILL WHITE

THE EMBLEM OF QUALITY

IMPORTANT INFORMATION ON MATERIALS HANDLING

This Bulletin

POINTS THE WAY TO SUBSTANTIAL SAVINGS

THIS new Mercury Bulletin No. 160 on "The Trackless Train" discusses a proved method of material handling adaptable to the widest variety of requirements. It describes equipment and methods of application to specific problems, and may be the means to an immediate and substantial saving in your material handling costs, as well as an improvement in operations throughout the plant.

Mercury equipment includes a full line of gasoline and electric powered tractors; castor steer, fifth-wheel, spring suspended, and other types of trailers in the widest range of standard and special models for the efficient handling of any kind of goods. Over 200 variations of the standardized Type "A-310" trailer have been developed and built and are available to meet individual needs. Many of these are illustrated in Bulletin No. 160. Write for your copy today.

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4110 South Halsted Street : : CHICAGO, ILLINOIS

"Banty" gas tractor and Type "A-310" steel box body trailers

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TRACTORS • TRAILERS • LIFT TRUCKS

Originators of

The **"TRACKLESS TRAIN"**
Method of Material Handling

the individual case, the limitations of which are contingent upon the complications that result.

Fixed or standby expense should be determined on the basis of the minimum expense possible as a going concern, but when working at higher points of activity the theoretical fixed expense should be used to minimize mathematical calculations.

Expected points that show radical departures from going standards are points requiring executive decision and should be clearly recorded.

The principles of the variable budget, if used for the control of expense, will furnish a simple, practical, personal tool.

[*So much for principles. Now for the application. The March half of Mr. Gardner's article tells how his company actually uses the variable budget to control manufacturing expense.—Ed.*]

•

Questions and Answers . . .

(Continued from editorial page 85)

Allowing for Development Expense in Maintenance Costs

Answers by Messrs. Baumbach and Scribner on page 472 of the November issue, in reply to H.E.W.'s question, bring up another matter in connection with the attempt to set up a departmental maintenance budget.

Our methods, machinery, and packages constantly are changed as improvements in production are developed. This constant changing means expense in development of ideas, breaking in new machinery, and experimenting with new methods. In order to keep down capital expense it is the practice of most firms, I believe, to absorb as much as possible of the development outlay in current operating expenses. If such expenses, which originate with the management, are a considerable part of the total maintenance expense of a department the control of the foreman over the maintenance burden of his department is noticeably affected.

Our production departments are working under a premium system based on time studies. Our maintenance departments are also operating on a premium system, but it is based on past costs of each maintenance department, considering the production of the plant as a whole. We wish to find some way to tie in maintenance costs in each department with the supervision premium, but the condition mentioned above makes us doubt the fairness and practicability of such a tie-up. How have other readers solved this problem? *H.E.S.—Battle Creek, Mich.*

IN A PLANT where shop operations are only in part repetitive and where it is necessary to make a new set-up of operations before each order is processed, I solved the problem in question by analysis of all time and motion studies on file and for current operations, tabulating the element times in standard minutes or points in chart and factor form. The basic elements, such as handling, were placed on charts and the machine and manual elements on factor tables, which include factors for modification and conversion.

The method of analysis and tabulation separated all

A New Kind of "Overhead" Is Brought to Your Attention

Sponsored by the Edison Electric Institute, the electric utilities of the country are conducting an elaborate campaign for Better Seeing Conditions.

John M. Sturges
Technologist, John W. Masury & Son
Brooklyn, N. Y.

FOR a long period, Industry has been thoroughly familiar with the existing relationship between Efficient Production and Adequate Lighting. But in the past three years of curtailed production and shut-down plants, comparatively little progress from this point has been made.

Originally introduced about June 1933, and appearing aggressively on the American scene in September is a compact, marvelous little affair called a Sight Meter (*Photo-electric cell, calibrated dial and indicator. See cut*). This Sight Meter is today receiving a tremendous amount of publicity as the direct result of the Better Light–Better Sight program sponsored by the electric utilities, the object of which is to acquaint the country with the vital importance and necessity for better seeing conditions.

The famous chain of Statler Hotels has fallen in line with this national movement. Perhaps you have seen the advertisements in the Saturday Evening Post and in numerous daily papers. Certified Lighting to meet every requirement of the visiting guest is featured. And the advertising text points out that every floor clerk has a Sight Meter and will be happy to satisfy the most inquisitive guest with answers to his questions.

To the executives of John W. Masury & Son (*Established 1835*) this Better Light–Better Sight program had a special significance.

During the past dull era, when, candidly, little paint was consumed by industry, the Masury paint laboratories were occupied with the measuring of Reflecting Factors of various colors and tints. Subsequently, this developed into something ever so much more vital and variable . . . . the PERMANENCE of these Reflective Qualities.

The Sight Meter

Research disclosed that among all recognized brands of paint intended for interior use in industry there was much to be desired. This investigation included our own materials, and we regret to say that they, too, fell below anything that approached the ideal. In fairness to ourselves, though, Masury's paints stood high on the list tested. A lot has happened since then.

A new Masury product has emerged from the chemistry of paint in which several new, revelatory principles are involved. This new Masury paint has an efficiency factor about 30% greater than current, available products intended for the same purpose. The items considered in this bold statement include: General Characteristics of the paint itself, Working Properties governing Spread and Hiding Power; Washability, an important factor in economy; Repaintability and finally, DRYING CHARACTERISTICS covering that trying period between application and final hardness when so many unexpected events in the life of a paint take place. All this, however, is another story to be told some other time. Should you want all the facts right now, you may have them. A letter-request will suffice.

Getting back to our story; in honor of the utilities campaign (*Better Light–Better Sight*), we elected to call this brand new Masury paint . . . BETTER SIGHT PAINT because it contributed so materially to the Better Light Movement.

Today, all Masury field men (*operating out of all principal cities on the Atlantic Seaboard*) are outfitted with Sight Meters. Another unit of their kit is the Visu-scope which enables them to show just what happens to lighting efficiency when Masury's Better Sight Paint is used. A Masury-man will call without obligation, at your request.

This brings us to the information that is important above everything else; how Industry may control and improve its seeing conditions.

In any room, the seeing conditions depend upon three things:

1. **The control of sunlight coming in at the windows.**
2. **The ability of the ceiling and walls to refine and distribute the light.**
3. **The artificial lighting.***

Of these factors, the most important is the distribution of light by reflection from ceilings and walls. The reason: Because the efficiency of the other two factors depends upon the ability of ceilings and walls properly to distribute the light. The ceilings are the most important distributors. That is why this brief is titled "A New Kind of 'Overhead' Is Brought to Your Attention."

Ask for these Bulletins: No. 112, Saving Money by Using SUNLIGHT to Its Maximum for Seeing Purposes. No. 126, Getting Your MONEY'S WORTH from Every Lighting Dollar.

Please address your inquiries to John W. Masury & Son (Established 1835), 50 Jay St., Brooklyn, N. Y.

*See your local lighting company.

(Advertisement)

HE CAN COOL OFF
but
YOUR WIRING CAN'T

Your men can cool off between heats, but your wiring must stay there and take it. So it's extremely important to use a wire that can go on working 24 hours a day, 365 days a year in places like this—ROCKBESTOS.

Whenever you must wire in a hot spot—a boiler, furnace, steam line, soaking pit or kiln—you need wire with permanent insulation—insulation that's not merely flameproof but *beatproof.* ROCKBESTOS is just such a wire. It's insulated with inert, inorganic asbestos—a material millions of years old— which cannot burn or dry up and which, when applied to the wire and impregnated by the ROCKBESTOS PROCESS, is unaffected by heat or moisture, oil, grease or fumes.

Give the wiring around those hot spots a real break—use ROCKBESTOS and eliminate the failures which with usual types of wire are regarded as a necessary evil.

You will find the wire you need in the ROCKBESTOS line which runs from small magnet wire up to 2,000,000 C. M. cable. Send for our catalog. ROCKBESTOS PRODUCTS CORPORATION, New Haven, Conn.

ROCKBESTOS
—the wire with permanent insulation

ROCKBESTOS PRODUCTS CORP'N
New Haven, Connecticut

Better send me that catalog.

Name .....
Title .....
Company .....
Address .....

operations into parts or elements in a form readily usable and easily applied so that all new operations or methods of performance that would otherwise be more or less experimental were set up synthetically as accurately as though time and motion studies of these operations were made, the work scheduled in the departments, and supervision, maintenance, and service premiums credited thereto along with all other production items.

For budgetary control of overhead expense, including maintenance, tools and supplies, and so on, an analysis of actual requirements per 100 standard minutes or points of production (using past records for reference only) was made, and budget figures for monthly periods showing daily allowances and date totals were set opposite corresponding production figures on a blackboard placed in the department offices.

Each day all department heads receive a report from maintenance and service departments, as well as from inventory or stores departments, of itemized costs of operating expense charged against their departments which, when accepted and checked against the day's production, is posted on the budget control board. Only the cost for the actual usage of equipment, tools, supplies, and so on is charged to operating expense, the department heads receiving a credit requisition for their return.

H. B. BAUMBACH, *Santa Monica, Calif.*

Locating Grounded Coils in Motor

When an insulation resistance test shows a ground to the frame on one phase of a three-phase motor, what is the best or quickest method of locating the defective coil? How can a short between phases best be located? *P.J.—Chicago*

WHEN AN insulation resistance test reveals a ground, or low insulation resistance, it is necessary to open the star or delta connections and test each phase winding individually with a test light or insulation resistance meter. When the defective phase has been located, open the group jumpers and test each group until the one containing the bad coil is found. Then test each coil in turn until the faulty one is reached.

It is well to remember, however, that unless there are very positive indications of a defect in the windings, such as extremely low insulation resistance, blowing of fuses, operation of protective devices, or heating, the procedure outlined above may not be justified. Low insulation resistance may be due to absorption of moisture, dirt, or possibly oil. By cleaning, drying in an oven, and applying insulating varnish the resistance often may be restored to the proper value.

A "growler" is often used for detecting defects in the windings of small motors. It consists of a low-voltage a.c. coil for establishing an alternating flux. Operation depends on the transformer action between the field set up by the growler coil and the coils of the motor winding. By placing the growler within the stator frame over each coil in turn any faults in the winding will be reflected in the readings of an ammeter in the growler circuit. Thus by observing any differences in the ammeter readings the defective coils can be found.

J. L. YOUNG, *St. Marys, Ohio*

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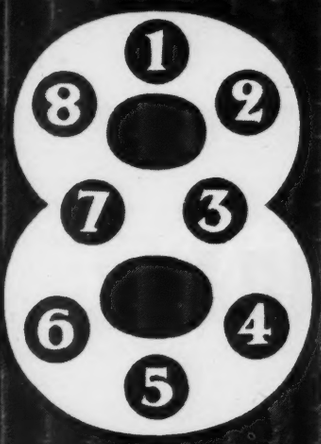

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(Continued from editorial page 55)

council meetings or through employee representatives, and I always had the feeling that they were trying to be fair to the management as well as to look after the employees' interest.

In one large department the council uncovered a payroll clerk who was conniving with other employees to cheat the company by padding the departmental payroll. This caused the management to put in a new payroll system which included a double check and was less expensive to handle. Also, through the interest of the council members in safety work, the accident record of the factory was improved.

There were many times during the ten years when things seemed to be running so smoothly that the meeting lacked the pep and punch of the earlier meetings. At these times the management put on a series of talks by department heads to acquaint the council members with various phases of factory operation, such as laboratory work and testing, plant maintenance, safety and health, inspection, product, design, elements of cost. Due to the knowledge gained through these talks ex-representatives often made good material for promotion.

Managing a factory with the aid of a works council through a period of sharply increasing cost of living and through a depression of moderate length, during which costs that were the highest in the industry were brought in line with the lowest, while earnings were increased and hours of work reduced, has convinced me that some form of works council offers the best plan for employees and employers in solving mutual problems.

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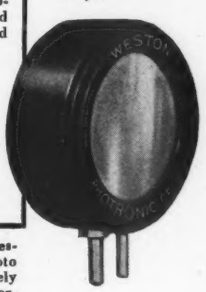

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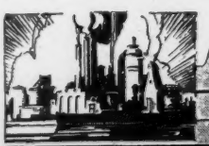

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